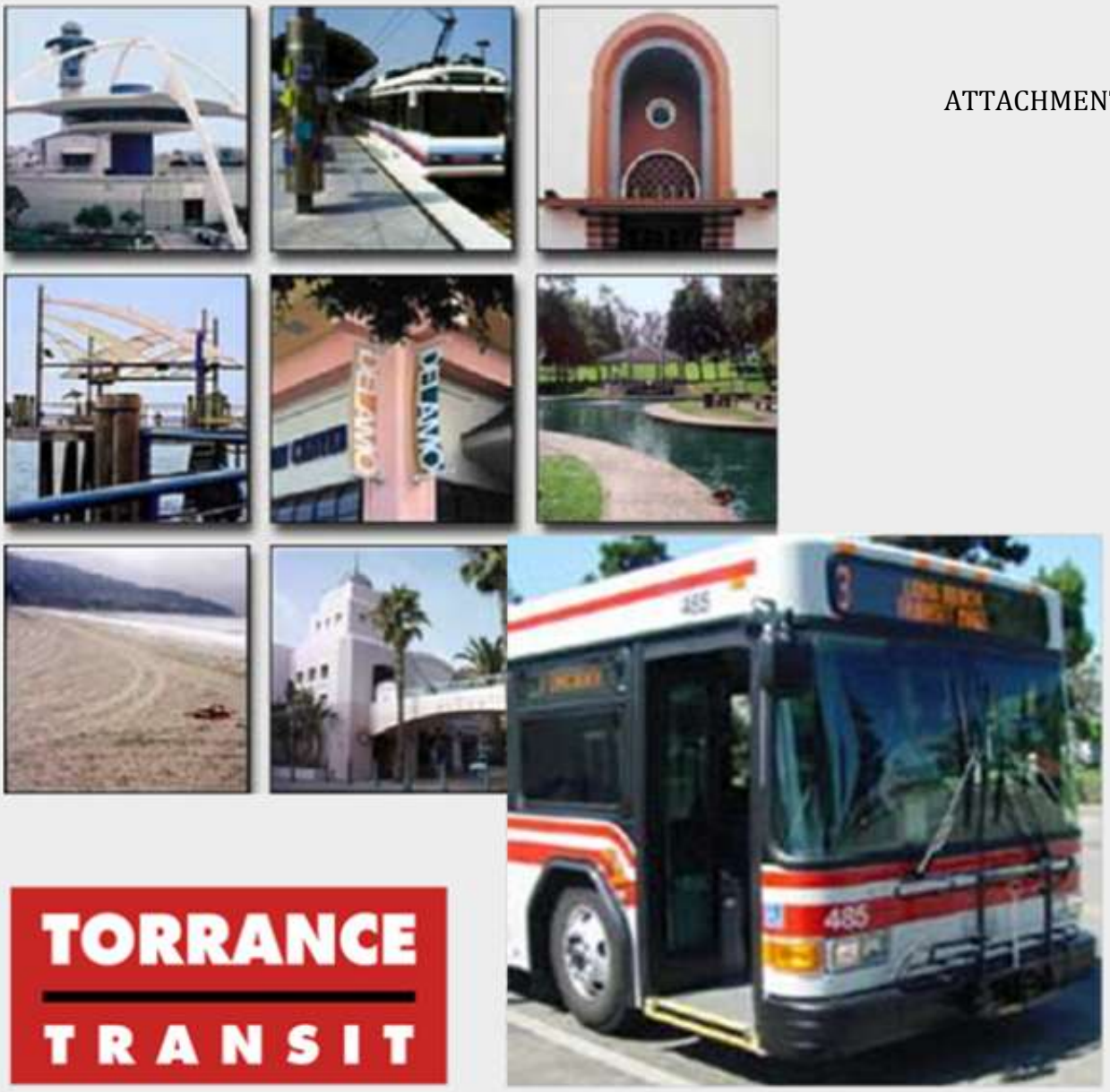
ATTACHMENT 7



TORRANCE TRANSIT

TRANSIT OPERATIONS MANAGEMENT SYSTEM
Technical Specifications

Prepared by:

EIGER TechSystems

August 2012

1 GENERAL

Torrance Transit Systems (TTS) has developed this Specification for a procurement of the Transit Operations Management (TOM) System.

1.1 INTRODUCTION

The mission of Torrance Transit Systems (referred to as TTS or Agency) is to provide reliable, safe, inexpensive, and courteous transportation to its customers—the people who live, work, and do business in the City of Torrance. TTS is implementing the Transit Operation Management (TOM) System to help TTS fulfill its mission. TOM is designed to be an efficient, effective, reliable, flexible, and expandable bus fleet management system to meet the needs of the TTS lead bus operators, bus operators, supervisors, police, management, and public ridership. The objectives of the TOM System are as follows:

- Provide improved delivery of transit information to the public.
- Improve operator and passenger safety.
- Improve operational efficiency.
- Improve service quality.
- Reduce bus fleet operation costs.

In an era of rapid technology advances and increasing interoperability requirements, the architecture of the TOM System must allow it to be easily maintained, upgraded, and expanded.

1.2 SCOPE OF WORK

The Contractor shall design, furnish, install, test, and make operational a TOM System for Torrance Transit Systems. The Contractor shall provide supporting documentation, training, and technical support, as specified in these Technical Specifications. The Contractor shall be responsible for all acts, tasks, equipment, system components, and services required to provide Torrance Transit Systems with a turnkey TOM System that is fully functional in accordance with the Contract and Specifications (collectively referred to as "Work"), whether or not such Work is specifically identified within this Agreement and the Specifications. Unless otherwise expressly agreed to in writing, all Work under this Agreement shall be performed by the Contractor. The seven primary functional areas of the TOM System are as follows:

1. Voice Radio Interface
2. Wireless Data Communication Subsystem
3. Computer Aided Dispatch
4. Computer Subsystem
5. Automatic Vehicle Location
6. Wireless Local Area Network
7. Interface to RIITS/511

In addition to these core functions, the following additional functionality may be included as part of the TOM System or implemented later:

- Automatic Passenger Counter
- Automatic Voice Annunciation
- Vehicle Health Monitoring
- Road Supervisor Subsystem
- Interface to UFS
- Bus Signal Priority
- Traveler Information Subsystem
- Interface to Video Security Subsystem

Torrance Transit Systems' bus operations and present usage of their voice radio system for dispatching shall not be affected prior to the completion of the TOM System. Thus, the TOM System shall be placed into service utilizing a careful, controlled cut-over procedure so as not to impact Torrance Transit Systems' operations.

1.3 TWO STEP PROCESS

Torrance Transit Systems will use the Specification—developed using the Form, Fit and Function (F^3) methodology—to solicit proposals as the first half of a two-step procurement process. This Specification describes the desired functionality and provides guidelines for a system design that will meet these functional requirements. Innovative approaches are encouraged in the proposals that will provide alternative means of meeting these functional requirements. Torrance Transit Systems requires proposers to specifically identify how their proposal varies from any approach set forth in the RFP, the benefits of their approach, and identify implications of the alternative. Proposals shall be clear in describing the exact approach intended. Specific requirements for technical content of the proposals are specified in Section 10.

1.4 SCHEDULE

The TOM System project duration from Notice to Proceed to System Acceptance shall not exceed twelve months.

2 TORRANCE TRANSIT SYSTEMS OVERVIEW

Contractor is responsible for obtaining all information regarding Torrance Transit Systems' existing systems required to perform its obligations under the Agreement. The following is provided for informational purposes only and does not relieve Contractor of its information gathering and investigatory obligations.

2.1 TORRANCE TRANSIT SYSTEMS OVERVIEW

Torrance Transit System is a branch of the City of Torrance that provides transit services in the Torrance, Long Beach, and surrounding areas. TTS' service area is bounded by Union station on the north, the Redondo Beach pier on the west, Pine Street in Long Beach on the south, and the Blue Line Del Amo Street Station on the east. TTS fleet comprises 63 buses (52 during peak operation) that run on eight lines. One of the lines provides Rapid Bus service. TTS will also soon begin running HOV lane buses. A map of the TTS lines is provided in Appendix G. TTS buses are primarily equipped with Mobile View 5 security video systems. TTS anticipates upgrading the final twenty vehicles equipped with Mobile View 3 security video systems within the next two years. There are no current plans to expand the vehicle fleet. TTS Operations is based at Torrance City Yard facility located at 20500 Madrona Ave. TTS hours of operation are from 4AM to midnight Monday through Friday, 5AM to 11PM on Saturdays, and 5AM to 10PM on Sundays.

TTS currently has 99 bus operators, five transit supervisors, four lead bus operators, and fifteen maintenance personnel. Transit supervisors and lead bus operators are cross-trained to perform both field supervision and dispatching job functions. TTS utilizes Trapeze FX for scheduling, OPS for transit operations management, and Blockbuster for runcutting. TTS also uses Maximus FleetFocus™ FA and FleetAnywhere™.

2.2 TORRANCE TRANSIT SYSTEMS VOICE RADIO SYSTEM

The TTS voice radio system utilizes one 25 kHz wideband channel pair at at 853.5125 MHz for transmission and 808.5125 MHz for reception. The base station relay site is located in Torrance at 5016 Calle De Arboles. TTS purchased 12 Motorola XLT 1500 800 MHz mobile radios for its buses in 2011. The balance of the TTS fleet will utilize newly purchased Motorola APX 6500 800 MHz mobile radios. Transit supervisors have Motorola APX 6500 mobile radios installed in supervisor vehicles and use Motorola MT2000 portable radios. The Quantar base station was installed in 2000 and is due for replacement.

2.3 UNIVERSAL FARE SYSTEM

TTS is planning to implement the Universal Fare System (UFS) that has been adopted by LA Metro and several other local transit providers. Cubic is the UFS contractor that will be delivering and installing GFI Odyssey fareboxes, with a main logic board that is a joint

Cubic/GFI product. The fareboxes will accept tap cards called the Go Card and Mifare, LA Metro tokens and cash.

As an option, Contractor shall establish an interface between TOM and the farebox to enable a single log-on to both systems via either the MDT or the farebox control head.

2.4 TELEPHONE SYSTEM

In Februay 2010, the City implemented a new NEC Univerge SV8500 telephone system at the City Yard. TTS has approximately 25 digital telephone sets connected to the City Yard switch. The system is fully integrated with AVST voicemail and NEC ACD/UCB systems, which are installed at City Hall. The voicemail system offers "phone trees" and the ACD system supports call center operations. (Note: It's the City's preference that even if the dispatch consoles include an integrated telephone set that the telephone operations be kept physically separate from the consoles. There are three or four telephones in the dispatch area. The City can exchange or modify the telephone sets as needed.)

3 TOM SYSTEM FUNCTIONAL REQUIREMENTS

This section describes overall design and performance requirements that shall be utilized throughout TOM. TOM shall meet the following performance requirements as an integrated system. These requirements span multiple individual Subsystems and System Components. Each individual Subsystem and System Component shall perform as necessary to support these requirements, in addition to Subsystem-specific and System Component-specific requirements stated in other sections of the Specification or Agreement.

Contractors are encouraged to supply standard, unmodified, service-proven products of computer and communication equipment manufacturers, established third-party hardware and software suppliers and their own baseline product offerings where they meet or exceed the functional requirements of this Specification. Contractor shall furnish the Contractor's most current hardware and software at the time of fleetwide installation. Contractor shall supply all standard features and functionality of the Contractor's most current product release at the time of system acceptance.

Proposers shall describe their standard offering in their proposals and highlight those proposed features that exceed specification requirements, and those features that need to be developed to meet the specifications.

3.1 DESIGN REQUIREMENTS

3.1.1 Capacity and Expandability

3.1.1.1 Number of Buses to be Served

TOM shall support at least 100 buses in operation.

3.1.1.2 Number of Buses during Pull-Out

TOM shall support power-up and pull-out of 100 buses in a one hour period.

3.1.1.3 Lines, Routes, and Runs

TOM shall support 100 lines, 200 routes and up to 2000 runs represented by six-digit alphanumeric identifications. TOM shall support interlining and shall support "tripper" assignments. A route is a significant variation in the operation of trips on a line. A run is a collection of mutually exclusive revenue and non-revenue trips.

3.1.1.4 Operating Schedule

TOM shall be capable of supporting a scheduled operating day that extends beyond 24 hours.

3.1.1.5 Operator ID's

TOM shall support five-digit operator ID's.

3.1.1.6 Bus and Supervisor ID's

TOM shall support four-digit bus and supervisor vehicle ID's.

3.1.1.7 Road Supervisors

TOM shall support up to ten Road Supervisor Subsystems in simultaneous operation.

3.1.1.8 CAD Consoles Allocations

TOM shall be equipped with CAD consoles, as further defined in Section 3.2 and 4.1 of this Specification. In addition, TOM shall be equipped with management monitoring positions that provide access to all TOM information, but do not have the radio and telephone communications features that the full dispatch consoles have.

3.1.1.9 Nomenclature and Familiar Terms

Text for labeling, messages, etc., shall use terminology that is consistent with existing TTS terminology. Examples include the following:

- Transit Director
- Transit Supervisor
- Transit Operations Manager
- Senior Business Manager
- Lead Bus Operator
- Bus Operator
- City Yard
- Equipment Attendant
- Mechanic

3.1.1.10 Expandability

TOM shall be designed to facilitate future expansion in functionality and transit operating conditions, through the use of open, fully documented interfaces.

TOM shall permit expansion without upgrading initial equipment, without restructuring initial software, and with no more than 5% degradation in the latency of data to support the following:

- eight CAD consoles
- sixteen management monitoring positions
- 100 operational vehicles
- ten Road Supervisor Subsystem equipped vehicles
- 100 lines
- 200 routes
- 2000 runs

Compliance shall be demonstrated as part of the Acceptance Testing as per Section 9 of this Specification.

TOM shall be designed to permit the addition of new functional capabilities over its lifetime without significant replacement of existing components. In particular, functions designated in this Specification as future or options shall be readily added to the system during its lifetime without costly rework or replacement of existing system components.

Proposers shall specify in their proposals how functions designated as future or options can be added to the system at a later time.

3.1.2 Open System Architecture

TOM shall be designed using off-the-shelf hardware and software to the maximum extent possible and shall be designed using Open System Architectures.

Open Systems Architectures, as used in the context of the TOM design, are systems that achieve the following objectives:

- Utilize components that have interfaces that are fully documented, non-proprietary, and based on a standard that is recognized by a standards-making body, such as IEEE, ANSI, SAE, and CCITT.
- Utilize components that are manufactured by several sources or are readily commercially available.
- Utilize components whose internal workings are fully documented and understood by a significant user and support community.
- Utilize custom components that were developed and documented in accordance with recognized programming architecture and standards and quality assurance procedures.

3.1.2.1 Software

All software, including firmware, (other than off-the-shelf operating system software from third parties) furnished as part of TOM shall be developed in accordance with IEEE software quality assurance procedures and shall utilize modern software engineering techniques, such as client-server and object-oriented software architecture. Current standard operating systems such as Windows 7, 2008 Server or later shall be utilized. Microsoft operating systems are preferred. A common high-level language, such as ANSI Standard C++, shall be utilized.

3.1.2.2 Databases

TOM shall retain and manipulate data as relational files using common database routines for definition and access. All parameters needed for administration shall be available through system administrator console operation. The Contractor shall provide tools for performance measurement and analysis as further defined in this Specification. Databases shall allow multiple users to access the data without significant impact on performance. Microsoft SQL databases are preferred.

3.1.2.3 Software Tools

Complete tools and all necessary files for managing, building, and testing software shall be included. Facilities shall be provided to support building and testing without impacting TTS operations. Installation tools shall be provided to enable coordinated, rapid, and secure updates at all site(s) and vehicles as further defined in this Specification.

3.1.2.4 Geographic Information System (GIS)

Contractor shall be responsible for complete geocoding of all TTS bus stops and routes as part of the TOM implementation, and shall provide a GIS database of the entire TTS service area and surrounding areas in an ESRI compatible format. TTS' standard is the Environmental System Research Institute's (ESRI) suite of software. The City of Torrance has ArcGIS, ArcInfo, ArcView, and Onpoint, ESRI ArcSDE, and ARCGIS Server and has access to ESRI maps that extend beyond the City's borders. TTS' Trapeze uses the Thomas Brothers map; however the City prefers use of ESRI maps.

3.1.2.5 Data Protocols

Data communications shall be based on standard, open protocols that conform to the Open Systems Interconnection (OSI) seven-layer model. These protocols shall include the following:

- The use of 802.3 - 2008 IEEE Standards for Local and Metropolitan area networks and IEEE Wireless LAN 802.11n–2009 or later
- The use of IP for wide area network communications.
- The use of TCIP, SAE, and EIA protocols for vehicle area network communications.

The protocol used for data radio communications may be implemented in the radio or an external modem. Open protocols are preferred. Documentation for the protocol shall be provided to Torrance Transit Systems <CDRL>.

In addition, specific consideration shall be provided for the following:

3.1.2.6 Regional ITS

TOM shall be designed such that access to real-time information can be provided to other systems at TTS, the Southern California 511, and the Regional Integration of Intelligent Transportation Systems (RIITS) network. The information shall be available through the Transit Database (TDB) for applications including, but not limited to 511, RIITS, bus signal priority and traveler information systems. Future implementation of NTCIP-compliant

center-to-center communications shall be facilitated through data deposited on the TDB. TOM shall comply with the LA County Regional ITS architecture (www.riits.net) and shall also facilitate future implementation of RIITS and 511 compliant interfaces.

3.1.2.7 Radio Subsystem

TOM shall provide voice communications via the existing TTS conventional radio system that is to be integrated with TOM by the Contractor. The voice radio channel could be used for a VOIP system. Interface to the existing voice radio system shall in no way interfere with or cause degradation to the existing system. It is anticipated that TOM will utilize approximately four talkgroups to support functionality defined herein. TOM shall be designed so as not to preclude the addition of voice channels and radio sites to the radio system. TOM shall be designed so as not to preclude future changes or modifications of the voice radio system to a trunked system.

3.1.2.8 National ITS Architecture

TOM shall comply with the intent of the National ITS architecture. Use of NTCIP framework and data dictionaries as per TCIP Standards 1400 through 1408 and SAE J2496, inclusive is desired for open standards compatibility. For onboard equipment, use of SAE Standards J1708, J1939, and J1587 shall also be acceptable for open systems, particularly for interfaces to existing onboard equipment that are compatible with these standards. New data elements not covered by these standards shall be compatible with the framework of these protocols.

3.1.3 FCC Compliance

The entire system and individual components thereof shall comply with applicable laws and regulations, including Code of Federal Regulations Title 47 (FCC regulations). The entire system and individual components shall comply with FCC safety requirements for RF exposure. In addition, particular attention shall be made to compliance with the following parts:

- Part 90 Private Land Mobile Radio Services
- Part 15 Radio Frequency Devices

TTS will provide to the Contractor information concerning its existing licenses. Copies of the current licenses are provided in Appendix I.

3.1.3.1 Mobile and Fixed Radio Equipment

All mobile radios, fixed radios, and cellular equipment shall be type accepted for the application intended in the TOM.

3.1.3.2 Spread Spectrum Radios

All spread spectrum radios shall be authorized as intentional radiators.

3.1.3.3 Other Equipment

All equipment that generates radio frequency energy, other than mobile radios, fixed radios, cellular equipment, and spread spectrum radios shall be FCC-authorized unintentional radiators.

3.1.3.4 FCC Licenses

In no case shall TOM or any System Component operate in a manner that is not in compliance with Torrance Transit Systems' radio station licenses.

3.1.3.5 Modifications to Licenses

The City of Torrance has obtained a license for a data channel as shown in Appendix I. If TOM uses radio for its data communications, TTS expects that the Contractor shall implement the subsystem using this radio channel. TTS will consider modifications to this license if recommended by the Contractor. Contractor shall bear the costs for license modification and shall prepare all license forms and attachments for written acceptance and signature by TTS. TTS will agree to submit applications for "reasonable" modifications to the FCC. Such reasonable modifications shall include the following:

- Changes to transmitter locations
- Changes to antenna heights
- Changes to emissions designators
- Addition of frequencies at a fixed site

Upon Torrance Transit Systems' signature, the Contractor shall forward such documents to the FCC <CDRL> or FCC coordinator, as appropriate. Sufficient time shall be allowed for this process in development of the Contractor's schedule.

3.1.4 Reliability, Availability and Maintainability

3.1.4.1 Availability

TOM shall include provisions to achieve high availability for critical functions through reliability of subsystems and System Components, elimination of single points of failure, through self-diagnostics and reporting of failures, and through maintainability of TOM.

The Contractor shall submit a reliability, availability and maintainability report that shall include data for each system element and analysis and calculations demonstrating compliance with these requirements <CDRL>.

3.1.4.1.1 Voice Communications

No single point of failure shall disable voice communications from the Dispatch Center to the existing radio system interface. TOM shall include fallback modes such as voice fallback.

3.1.4.1.2 Data Communications

No single point of failure shall disable data communications from a Dispatch Center to the bus fleet, other than failure of Onboard TOM equipment on a single bus or the data link to either the radio site or internet site for the cellular carrier.

3.1.4.1.3 Consoles

Each console shall have all functions available at least 99.8% of the time, based on 24 hour a day operation, 365 days a year.

At least half of the consoles shall have all functions available at least 99.9% of the time based on 24 hour a day operation, 365 days a year.

No single point of failure shall disable both radio communications at more than one dispatch console.

3.1.4.1.4 Telephone Access

No single point of failure shall disable access to telephone lines for incoming and outgoing calls to more than one dispatch console.

3.1.4.1.5 Onboard TOM Equipment

The full specified functionality for the Onboard TOM equipment for each bus shall be available at least 99.7% of the time, based on 24 hour a day operation, 365 days a year.

3.1.4.1.6 Data Logging

The ability for TOM to correctly log data from buses, without lost events, shall be available at least 99.9 % of the time, based on 24 hour a day operation, 365 days a year. Measurement of this parameter assumes that the bus is within TOM radio coverage.

3.1.4.2 Maintainability

TOM maintainability shall support the specified availability requirements, given the expected equipment reliability. The entire TOM System shall be constructed such that the average maintenance time (including diagnosis, all repair and preventive [scheduled] maintenance time) by personnel who have received and completed training provided by the Contractor is no greater than two hours per bus per year. Maintenance of TOM Dispatch Center equipment and software shall require no more than 500 aggregate personnel-hours per year. Failure of the Contractor to perform adequate training shall not relieve the Contractor of this requirement. Maintenance requirements in this paragraph shall apply to new Equipment, and shall not increase by more than four percent annually as TOM ages.

In addition, TOM subsystems and system components shall meet the following requirements:

3.1.4.2.1 Onboard Equipment

TOM shall include self-diagnostics and shall automatically report and log failures for each onboard subsystem. Failures of Onboard TOM equipment shall be displayed for the operator.

Replacement of each individual component of onboard equipment, including any optioning, or program downloads and functional testing, shall be completed by two trained Torrance Transit Systems technicians within twenty minutes. Replacement of a complete set of Onboard TOM equipment, excluding cables and antennas but including the setting of any required options (switch settings or software options), program downloads, and functional testing; shall be completed by two trained Torrance Transit Systems technicians within one hour.

3.1.4.2.2 Console Equipment

The console equipment shall be replaceable without disruption to other consoles or TOM as a whole. When a replacement console is brought on-line, it shall not require more than two minutes after connection and power up for the console to be ready for log-in.

3.1.4.2.3 TOM Network Processors

All processors on the TOM network in the Dispatch Center shall be replaceable without taking down other processors and without loss of data.

3.1.5 Response Times

Response times shall be measured with the full design operational fleet active, under normal operating conditions, unless otherwise specified.

The Contractor shall submit a response time analysis report that shall demonstrate that the system will achieve the required response times <CDRL>. Analysis shall be based on actual measured times for similarly equipped systems and laboratory measurements on a system configured to resemble TOM.

3.1.5.1 Requests From Buses

The elapsed time between activation of an SAS to correct display at TOM consoles shall not exceed three seconds with 99% probability and shall not exceed fifteen seconds with 99.9% probability.

The elapsed time between activation of a RTT or PRTT to correct display at TOM consoles shall not exceed five seconds with 99% probability and shall not exceed thirty seconds with 99.9% probability.

The elapsed time from a text message sent from a bus to correct display at TOM consoles shall not exceed five seconds with 99% probability and shall not exceed thirty seconds with 99.9% probability.

3.1.5.2 Bus Status

Current location and operational status (early/late) of each bus shall be available at the Dispatch Center at least every minute.

When a bus goes off-route, this elapsed time until display at TOM consoles shall not exceed five seconds with 99% probability and shall not exceed thirty seconds with 99.9% probability.

3.1.5.3 Power Up Data

When a bus is powered up, this status shall be logged by TOM within five seconds with 99% probability and shall not exceed ten seconds with 99.9% probability.

Operator log-in shall be logged by TOM and verification provided back to the operator display within five seconds with 99% probability and shall not exceed ten seconds with 99.9% probability.

3.1.5.4 Console Response

The total elapsed time from console user log-in to complete display of complete tabular and graphical information for his work assignment shall not exceed five seconds.

The total time from power-on or re-boot of a console to display of the log-in screen shall not exceed two minutes.

Entry of textual data shall be accepted immediately (without noticeable delay) and without lost characters under all conditions.

Map displays shall be completely redrawn, whether panning or jumping, within three seconds, including bus location icons.

3.1.6 TOM Interfaces

TOM shall interface with existing Torrance Transit Systems systems and the capability to interface with new systems that are not a part of this Contract. TOM shall interface to regional ITS projects including the RIITS network as a Level 1 participant (riits.net), and the Universal Fare System (UFS). In addition, there are ongoing Torrance Transit Systems contracts that the TOM Contractor shall be required to interface with in executing the Work under this Contract. Integration, coordination, scheduling, and communications with these systems and contracts shall be provided by the TOM Contractor, as per this Agreement.

3.1.6.1 Torrance Transit Systems Network

TOM shall share data with the applications that reside on the City of Torrance network via a Transit Database and firewall/router as per this Agreement. The Transit Database (TDB) shall provide for bi-directional data transfer to support multiple applications, as detailed in this Specification, including the following:

- Import of schedule information from Trapeze
- Import of route traces and GIS data
- Import of work assignments
- Import of employees data including ID's
- Import of vehicle data
- Export of reports
- Export of real-time transit information (for customer information and management)
- Export of system alarms and diagnostics
- Export of video data

The Contractor shall provide all necessary conversion utilities to provide data to the TDB in a format usable by the TTS applications and to read data provided by the TTS applications. Interfaces shall be configured such that TOM automatically initiates requests for information and completes data transfer without manual intervention. TTS will furnish the definitions of these data to the Contractor.

3.1.6.2 Interfaces with Torrance Transit Systems Network

The Contractor shall provide a firewall/router to protect against unauthorized database access or modification from outside the TOM network. The firewall/router shall be based upon the latest Cisco ASA 5500 Series or approved equal. This firewall shall be fitted with a minimum of three Gbit/s Ethernet ports.

The interface between City of Torrance LAN and the TOM shall enable exchange of data. Data produced by TOM shall be provided to the TTS network for reports and analysis. Data produced by TTS shall be provided to TOM for operation management.

The Contractor shall provide software to transfer operating results data to the TDB on a timely basis to meet the reporting requirements of these specifications. The Contractor shall furnish to Torrance Transit Systems the definitions of the TOM data on the TDB. The data shall be in a form that is accessible through SQL.

3.1.6.3 Dispatch Center and Computer Equipment Space

Two dispatch consoles shall be installed in the TTS dispatch area. The Contractor shall provide information to TTS regarding physical and installation requirements for this space, including console layout, equipment layouts, floor loading, cableway requirements, power requirements (normal and back-up), lighting, grounding, heat load, and ventilation <CDRL>. Since space in the existing dispatch room is limited, the Contractor's plan for cut-over shall

be designed and coordinated to accommodate such space limitations. A tour of the dispatch area will be provided during the pre-bid meeting.

3.1.6.4 Bus Procurements

TTS has ongoing bus procurement contracts. The Contractor shall work with TTS in scheduling equipment installations on new buses before they are placed in service and preventing equipment installations in buses that are to be removed from service. The Contractor shall submit a bus installation plan showing the complete list of buses and the locations for the installation <CDRL>. This plan shall include the dates and duration of each installation.

Contractor shall provide option pricing for the purchase of additional Onboard TOM subsystems for installation of future bus purchases by TTS.

3.1.6.5 Existing Bus Equipment

TOM shall interface to multiple existing subsystems that are onboard TTS buses, including, but not limited to voice radio, video security equipment, public address equipment, headsigns, engine control computers, transmission control computer, driver interface computers, odometers, and power supplies. Appendix D summarizes TTS' bus models and information on existing equipment. The Contractor shall develop TOM to accommodate all existing equipment configurations. The Contractor shall consider this variety of existing equipment in all aspects of TOM and shall develop, document, implement, and control all interfaces <CDRL>. The Contractor shall be responsible for all Work necessary for seamless interface with existing bus equipment.

3.1.6.6 Utilities

The Contractor shall coordinate with the City's telecommunications section to order and install all necessary telephone lines. All charges associated with such telephone lines, including but not limited to installation, ducting, and trenching charges shall be included in the Contractor's price proposal. TTS will be the billed party for the monthly charges.

The Contractor shall coordinate with the City's Wireless Section to order from an approved wireless service provider for any wireless data or similar service. The City's wireless section must approve any agreement between Contractor and the wireless service provider, including the Service Level Agreement. Activation charges shall be included in the Contractor's price proposal.

The Contractor shall coordinate with the City's electrical shop for the order or purchase of any installation of new electric services required. Installation charges shall be included in the Contractor's price proposal. TTS will be the billed party for monthly charges.

Where new communications or power lines are involved, the Contractor shall coordinate with the responsible City representatives prescribed above when determining responsibility for all supplies and Work involved in the installation of any overhead or underground

conduits for cable, providing adequate electrical service for the system components and any other Work necessary to render these system components fully functional in accordance with the Agreement and these Specifications, regardless whether such material, supervision, equipment or Work are specifically identified within the Agreement and these Specifications. All such Work shall meet all applicable codes. Subject to coordination with the responsible City representatives, all electrical requirements and all cable to the extent indicated in these specifications shall be furnished by the Contractor. Plans for such Work must be submitted by the Contractor no more than 60 days after notice to proceed and for Acceptance by Torrance Transit Systems <CDRL>. TTS shall notify the Contractor of its response to this information and request for Acceptance no less than sixty days prior to installation. The Contractor shall be responsible for building permit costs and and all costs to obtain acceptance of the permit.

3.1.6.7 Graphical User Interface

The Contractor shall develop details of the TOM graphical user interfaces (GUI) in cooperation with TTS personnel. The Contractor shall conduct at least one workshop with TTS focus groups in development of GUI details. The Contractor shall provide color drawings or mock-ups of proposed user interfaces for input by Torrance Transit Systems focus groups <CDRL>. In addition, the following guidelines shall be utilized:

3.1.6.7.1 Terms Used

Terminology that is specific to TTS shall be utilized, as defined in this Specification and Appendices.

3.1.6.7.2 Single Layer Access to Functions

TOM shall generally provide access to the most frequently used functions through a single layer of commands.

3.1.6.7.3 Access Relations On-line/Automatic

TOM shall generally provide all data online (such as SQL statements) which is needed to access any other online data through a single layer of commands.

3.1.6.8 Mobile Data Terminal Ergonomics

The Contractor shall develop details of the Mobile Data Terminal (MDT) in cooperation with Torrance Transit Systems personnel. Key terms that are specific to Torrance Transit Systems shall be utilized. The Contractor shall conduct at least one workshop with TTS focus groups in development of the Mobile Data Terminal user interface details.

3.2 COMPUTER AIDED DISPATCH

Torrance Transit Systems will use TOM to manage bus operations from its Dispatch Center. The bulk of the work at the Dispatch Center will be carried on by lead bus operator(s) at

TOM consoles. A lead bus operator will generally be overseeing an assigned set of bus lines, handling exception conditions from the time buses leave the bus yard with scheduled drivers at scheduled times, until buses return to the yard. They will handle bus radio calls and other events from a TOM-maintained queue, making radio or other calls to gather information and distribute instructions. They may change routes, schedules, and other assignments as necessary to maintain bus service. The Transit Operations Manager or Senior Business Manager may pick up some of the workload or review the on-going work of a lead bus operator.

This section describes functions that TOM shall provide at the Dispatch Center to support lead bus operators, route rupervisors, Senior Business Manager, Transit Operations Managers, police, and fleet management activities.

3.2.1 Console Designation

TOM shall accept, based on password control, privileges at any console for users designated as Transit Director, Transit Operations Manager, Senior Business Manager, Transit Supervisor, Lead Bus Operator, Equipment Attendant, or Mechanic.

3.2.2 Console Designation

TOM shall accept from a Senior Business Manager or Transit Operations Manager; the line, priority and user group assignments for each dispatch console, which defines the calls and status information to be received by those consoles.

3.2.3 Console Work Assignment

Where more than one console has accepted or been given assignment of a particular line, TOM shall make calls and status information for that line available to all such assigned consoles. TOM shall also have the ability to assign groups and priorities to multiple consoles.

3.2.4 Call Routing

TOM shall have the ability to route specific calls to consoles depending on their designation. TOM shall route all unassigned calls to an active console.

3.2.4.1 Notification of Unassigned Call Handling

TOM shall make notification at the console of any unassigned call handling.

3.2.4.2 Transfer Assignment

TOM shall provide functionality to transfer a dispatcher's work assignment and calls to another dispatcher if the first dispatcher must temporarily leave his or her console. If the transfer is marked as permanent, the dispatcher that is leaving shall automatically be logged off.

3.2.4.3 Call Queue Management

TOM shall manage the stream of voice radio calls made to the Dispatch Center, data messages from operators, bus alarms and similar events, and Incident Report reminders ("callbacks"), and present these as a queue to the assigned console(s).

TOM shall provide comprehensive user tools for selecting the detailed methodology of handling calls within queues.

- Calls shall be sorted by priority by type (SAS, RTT, PRTT, Data, etc.)
- For a given priority, oldest calls shall appear above newer calls
- SAS calls shall always have top priority and shall generate an audible alarm.
- Lead Bus Operators have the ability to select any call in the queue at any time.
- The queue information shall be displayed in a scrollable window.
- Multiple calls from a bus shall be eliminated, with the highest priority and then oldest call retained. All calls shall be logged.
- For each call, the dispatchers shall have the option of opening an incident report.
- Incident reports that have not been closed shall appear in the queue as a reminder or be listed with a Pending status.

3.2.4.4 Outgoing Calls

TOM shall support outgoing radio calls in the manner described below.

3.2.4.4.1 Call to Bus, Transit Supervisor Vehicle

TOM shall enable console action to initiate a call to a selected bus or supervisor vehicle either by entering the bus number, line/run number, driver identification, or by selecting the bus or supervisor from a list in a tabular display or an icon on a graphical display.

3.2.4.4.2 Channel Selection

TOM shall enable console action to use a specified talk-group to maintain voice contact with a group of buses and transit supervisors, in the event of a failure of the normal radio control system.

3.2.4.4.3 Announcements to Buses or Supervisor Vehicles

TOM shall support issuing either voice or text announcements to bus operators and supervisor vehicles. TOM shall allow the dispatcher at a dispatch console or Road Supervisor MDC (Option) to send an audio or text announcement to a bus, subgroup, group, line, all buses, or supervisor vehicles.

3.2.4.5 Other Communications Management

TOM shall support the following communications management functions.

3.2.4.5.1 Test SAS

TOM shall provide for automated testing that SAS is operational upon power up of each bus. Performance of SAS tests and results shall be logged for reporting.

3.2.4.5.1.1 Text Messages to Buses or Supervisor Vehicles

TOM shall accept both keyboard-entered and selected pre-defined text messages at a dispatch console, and transmit those messages to the selected buses or supervisor vehicles. TOM shall allow dispatchers to append pre-defined text messages. TOM shall maintain a visible list of unacknowledged text messages, and shall inform the console user when the acknowledgement has not been received within a system administrator-settable time.

3.2.4.5.2 Patches

TOM shall provide for patching of selected radio calls and intercom channels.

3.2.4.5.3 Audio Output

TOM shall provide for selection of audio output of active radio to either console headset or primary console speaker.

TOM shall be capable for selection of a second call (listen mode) on a secondary console speaker in the event TTS obtains a second voice channel. TOM shall provide for muting at each console.

3.2.4.5.4 Audio Playback

TOM shall provide a console feature that allows selection and playback of a recording of at least the last five radio, phone or intercom connections, and shall link the recordings with a display of any open Incident Reports associated with the connections.

TOM shall provide capability to transfer a selected connection recording to another console for playback and for display of the associated Incident Reports.

3.2.4.5.5 Voice Fallback Mode Initiation

TOM shall provide a console feature that allows TOM to be manually placed in voice fallback mode.

3.2.5 Operations Status

Operations status entries shall be generated automatically by TOM when an out-of-tolerance condition is detected. The system administrator shall have the capability to turn on or off data calls by line, or bus and the ability to set the tolerance parameters.

As a minimum, TOM shall generate notifications for the following bus conditions:

- Off route
- Schedule adherence variance
- Uncorrelated vehicles operating outside a bus yard
- Out late
- Cancel
- Missed relief
- Failure to communicate with bus
- Vehicle movements without a valid logon

Tolerances for determining each abnormal condition shall be settable by the system administrator. Enabling or disabling of reporting of each condition shall be user settable, based on routes, vehicles, and times.

3.2.5.1 Log-In Data

TOM shall validate bus status data, alert assigned console of out-of-bounds or inconsistent data, and allow for manual correction of data.

3.2.5.1.1 Validation

TOM shall validate bus operator-entered identification against assignment, line, run, and vehicle.

3.2.5.1.2 Invalid Bus Operator Identification

TOM shall report the entry of invalid bus operator identification to the dispatch console where the operator's bus is assigned.

3.2.5.1.3 Correction

TOM shall enable remote bus logon and the correction of invalid bus data at the dispatch console where that bus is assigned.

TOM shall allow the disabling of location information from a bus in the event that the location system on a bus malfunctions.

3.2.5.2 Bus Device Status and Control

TOM shall support control of devices on buses, either through automatic detection of operation criteria, or through lead bus operator action.

TOM shall log each bus device control action that TOM or console action initiates.

TOM shall support the interface of bus mechanical alarms and device alarms from bus subsystems such as TOM in-vehicle equipment, video system, and fare box. Alarms and equipment status data shall be provided to the Dispatch Center via the data radio and the Yard Wireless LAN. TOM shall make this data available for display at the dispatch consoles and shall provide this information to the TDB for the purpose of scheduling maintenance.

3.2.5.3 Bus Status Data Display

TOM shall display the conditions, location, and route/schedule adherence of buses at the dispatch console(s) to which they are assigned. The display shall be a combination of geographic and text/tabular presentation.

3.2.5.4 Geographic Display

TOM consoles shall display a geographic map representation of the selected buses or supervisor vehicles that include streets with names, routes, detours, and various jurisdictions.

The Contractor shall ensure the following:

- TOM shall permit zooming, panning and scrolling of the geographic display and selecting the details displayed associated with a zoom level.
- The highest-level map display shall include all of Torrance Transit Systems service area and Torrance Transit Systems designated portions of adjoining areas out to ten miles beyond the service area.
- The lowest level map shall show all streets, roads, railroad tracks, water boundaries, jurisdictional boundaries, bus stops, transfer points, and significant landmarks within the displayed area.
- TOM shall allow centering geographic display on a specified bus and tracking that bus automatically by panning and scrolling the display as necessary. TOM shall automatically center the display on a vehicle with an SAS status while the SAS is active.
- TOM shall allow centering geographic display on specified lines, stops, and time points.
- Bus icons and associated text shall be easily legible without overlap at the lowest scale, even within high-density areas where many buses will frequently appear in the same area on the screen.
- TOM shall allow selection of graphic representation of a bus to display text/tabular display data about that bus.
- Maps shall include a complete road map, as well as current route maps.

- Maps shall reflect all current or planned schedules and routes (including weekday, Saturday, Sunday and Holidays).
- TOM shall display upon request facilities locations, route of line instructions, operating procedures, and miscellaneous reference material. Facilities locations shall be in graphics form as part of bus graphics data and also in tabular form.

3.2.5.5 Text/Tabular Display

TOM shall display selected lists of data, including bus schedules, driver identification, assignments and schedules, pull-in/layover status, back in service time/place, schedule and route adherence, and passenger loading.

3.2.5.6 Incident Reporting

TOM shall support collection and recording of bus information for Incident Reports through the automatic collection of data from buses and from manual input to screen forms at consoles and MDCs.

3.2.5.6.1 Incident Report Identification

TOM shall create unique identification for Incident Reports as they are created.

3.2.5.6.2 Automatic Data

TOM shall collect and record bus status data, bus run, route and schedule deviation, time, bus operator identification, bus identification, location, bus alarm status, other pertinent bus information, system date and time, console identification, and lead bus operator, transit supervisor, or police identification, and record them as part of each Incident Report. The status of affected vehicles shall be automatically updated by TOM when appropriate by the processing of incidents.

3.2.5.6.3 Manual Data

TOM shall accept from a console and record manually entered text, coded, combo-boxed or check-boxed notes, and an indication that the incident is closed or the report cancelled. TOM shall log changes made to each of the information field of an Incident Report, recording the contents, time, and identification of the person logged in at the console where the change is made. TOM shall provide a spell checker tool for manually entered text.

3.2.5.6.4 Incident Report Access

As part of answering a bus call, TOM shall allow either selection of possibly related recent reports to open for update or expansion, or opening of a new Incident Report.

- TOM shall enable accessing Incident Reports at a console.
- Access shall be by bus operator identification, bus identification, line/run identification, lead bus operator identification, incident code type, date, or Incident Report identification.

- TOM shall also allow access to Incident Reports, which have been entered into a call queue for reassignment or subsequent processing as described below.

3.2.5.6.5 Incident Report Association

TOM shall search through open Incident Reports and provide display of any potentially related Incident Reports to lead bus operator upon retrieval or closure of an Incident Report. The TOM dispatch console shall display associated Incident Reports in creation order, oldest first, to lead bus operators with proper access privileges.

3.2.5.6.6 Report Assignment

TOM shall accept a command from a console to assign an Incident Report to another console.

TOM shall enter the Incident Report into the call queue of the recipient at its same priority and in the order it was first received by TOM.

3.2.5.6.7 Incident Coding

TOM shall accept and record with each Incident Report a code consisting of three levels of alpha/numeric characters. TOM shall maintain a database of codes and validate entries against that database.

3.2.5.6.8 Incident Report Sub-functions

TOM shall support a number of subfunctions that are associated with reporting incidents, as described below. A selected set of these functions shall send notifications of need for follow-up actions into the call queue, at an appropriate priority and time or event as specified in the sections below. Access to records of these functions for a given Incident Report shall be provided in a fixed order of the segments such as for subsections below, and in chronological order of the events that created them.

3.2.5.6.8.1 Comments

TOM shall accept and record comment text made by a lead bus operator.

3.2.5.6.8.2 Incident Report Transfer

TOM shall accept from a lead bus operator a request to transfer responsibility for an Incident Report to or from a specified lead bus operator or transit supervisor.

3.2.5.6.8.3 Notification

TOM shall accept a request from a lead bus operator to notify a specified individual of an incident by forwarding the Incident Report to that individual.

3.2.5.6.8.4 Routing List Changes

TOM shall accept changes to a standard distribution list to which the Incident Report will be routed.

3.2.5.6.8.5 Bus Service Changes

TOM shall accept a description of a bus change of service and use that data to determine service status, correct APC correlation and correct AVA announcements. TOM shall accommodate the following service changes:

- Deadheads
- Bumps
- Relays
- Doubles
- Outlates / Cancellations
- Detours
- Assignment Cancellations

3.2.5.6.9 Accessible Service Operations

TOM shall automatically record wheelchair patron boardings and alightings as indicated by the bus operator, as well as location, time, vehicle ID, line, run and direction. TOM shall accept notes from a lead bus operator regarding failures of accessible equipment such as ramps or lifts.

3.2.5.6.10 Accidents

TOM shall accept lead bus operator descriptions of an accident. Upon completion of the entry, TOM shall transmit notification to the bus yard workstation by activation of a button. TOM shall report back when the Yard Workstation has received the Incident Report.

3.2.5.6.11 Police Calls

TOM shall accept from a lead bus operator a description of a call to police as a set of manual inputs.

3.2.5.6.12 Road Call Initiation

TOM shall initiate road calls by immediately transmitting selected Incident Report data to the TDB. TOM shall report back to the initiating console that such Incident Reports have been received and the data made available via the TDB to applications on Torrance Transit Systems Network.

TOM shall immediately cause an audible alarm at the bus yard workstation for the involved bus, and shall present selected Incident Report data at that workstation.

3.2.5.6.13 Incident Report Forwarding

TOM shall have the capability to export, on demand, closed Incident Reports in a format that is currently used by users on Torrance Transit Systems Network (for word processing, spreadsheets, and databases) at the time of acceptance. TOM shall facilitate routing the Incident Reports to specific users by attaching a problem or incident type code to each report, which can then be used to invoke a City of Torrance LAN-resident list for code and use the Torrance Transit Systems email system.

3.2.5.6.14 Incident Report Historical Tracking

TOM shall maintain a log of assignments and modifications to each Incident Report.

3.2.5.6.15 Incident Report Storage

TOM shall maintain a local copy of closed Incident Reports for at least thirty days. TOM shall automatically delete older Incident Reports, if they have been successfully transferred to the TDB.

3.2.5.6.16 Incident Report Procedural Assistance

TOM shall provide pre-defined procedural checklists for selected types of incidents.

- The checklists shall direct console operator to Incident Report fields as appropriate.
- The checklists shall include, as appropriate, automatic links to various communications media such as telephone calls and electronic mail for others who may need to be notified about the incident.
- The checklist shall be cancelable at any stage.

3.2.5.7 Changes of Operator/Vehicle/Line/Run Assignments

TOM shall accept from a console additions and amendments to any assignment of operators, lines/runs, or vehicles. TOM shall update all necessary locations after changes have been made and ensure that all TOM components that may require this information have access to the updated information.

3.2.5.8 Senior Business Manager or Transit Operations Manager Support

TOM shall provide support for Senior Business Manager or Transit Operations Managers by accepting their log-in at any console. Once logged in, they shall be able to do the following:

- make changes to schedule adherence tolerances
- make changes to load reporting tolerances
- display call queues

- listen in on radio transactions of any selected lead bus operator, with audio notifications provided automatically, per applicable laws

3.2.5.9 Bus Route, Patterns and Schedules

TOM shall have the capability to receive, process, and import TTS route, pattern schedule, and related types of data and information from Trapeze scheduling software. Bus schedules are identified by Schedule Number (a unique identifier), Effective Date, Revised Date, and Service Type (DX, SA, or SU).

TOM shall have the ability to incorporate changes either on demand or at a scheduled time.

TOM shall also have the capability to accept changes to the bus route, pattern and schedule data from a console for full or ad-hoc changes and detours at the trip, run and line levels. Changes shall be entered utilizing simple, menu-driven forms. The data entered online shall include the effective dates and pattern identifiers that identify the part of the schedule that is to be put in or removed from effect. TOM shall immediately pass selected data about the change to the Transit Database. TOM shall utilize the modified definition of the route, pattern, and schedule for all TOM tracking and reporting functions for the duration that the modification is in effect.

TTS schedules are created in Trapeze FX. TTS also uses Trapeze OPS and BlockBuster. Trapeze OPS, Blockbuster and FX have all been upgraded to version 11.0.9.0.

3.2.5.10 Personnel Management Support

TOM shall accept, store, and display information to assist in making assignments and keeping records for bus operators. TOM shall display assignments of operators to lines/runs, or vehicles on the Dispatch Center consoles, when selected from any console and at appropriate display detail levels.

3.2.5.11 Text Messaging

TOM shall support real-time text messaging between TOM consoles. TOM shall support real-time text messaging with Torrance Transit Systems Network through depositing text messages and destinations on the TDB and through software provided for the Torrance Transit Systems network to deposit or pick up and forward text messages.

3.2.5.12 Management Reporting

TOM shall collect data for bus, staff, and TOM operation and performance and send data to the TDB. TOM shall produce standard fleet management reports and a reporting tool for custom queries. Torrance Transit Systems will consider suitability of Contractor's standard reports in the proposal evaluation process.

3.2.5.12.1 Bus Operations

TOM shall collect information for production of reports on the following:

- Trips, including trip ID, schedule type, line, run, direction, vehicle ID, operator ID, trip miles, passenger boardings and alightings, wheelchair boardings and alightings, revenue collected, and other pertinent information
- Stops, including vehicle ID, line, run, time of stop, passenger boardings and alightings, wheelchair boardings and alightings, trip ID, and other pertinent information
- Timepoints, including vehicle ID, line, run, time of timepoint passage, trip ID, and other pertinent information
- Bus vehicle health monitoring data, mechanical alarms, Onboard TOM equipment status, and other events
- Summary data on trip number, line, run, day of week, time period, operator ID, vehicle ID, schedule adherence, passenger boardings and alightings, wheelchair boardings and alightings, and revenue collected. Summaries shall be for weeks, months, quarters, and years
- Vehicles, including location, mechanical alarms, passenger counts, and schedule/route adherence for scheduled, unscheduled, and ad hoc runs
- Unusual operating conditions and detours
- Road calls
- Lead bus operator information such as bus and line assignments, action events such as bus calls and alarms, and dispatcher responses, all with time tags for analysis.
- Current status of service (on 15 minute update cycle), showing any active SAS, number of buses currently on routes, percent of fleet on time, percent of fleet late, number of scheduled runs missed for the day, and total number of calls currently in queues.

3.2.5.12.2 Fleet Management

TOM shall collect information for production of tabular and graphical reports on the following:

- Bus assignments; including changes to assignments, pull-outs, and pull-ins
- Run cancels or outlates
- Service delays, including type, reason, length of delay, service loss, mileage lost, and resolution
- Dispatch performance, as measured by call processing time categorized by problem type entered in the Incident Reports
- Schedule adherence, including identification of events outside of adherence parameters
- Passenger loading and alighting counts and door open/close times for each stop
- Wheelchair loading and alighting, including lift operation times
- Data for FTA NTD Report including passenger miles and vehicle miles
- Bus availability, including reasons for unavailability

Additional reports are listed in Appendix B.

3.2.5.12.3 Employee Management

TOM shall collect information for production of reports on the following:

- Operator assignments and assignment fulfillment
- Incident Reports involving operator error
- Accident Reports
- SAS reports by operator, and line

Reports shall be available for selectable time periods, initially by month.

3.2.5.12.4 Ad Hoc Retrieval from Logs

TOM shall enable ad hoc selective retrieval of event records of bus, operator, transit supervisor, and lead bus operator activities, by bus, operator, route, lead bus operator, transit supervisor, and event type or time interval.

Retrieval shall be by user-specified criteria, including the use of the logical operators AND and OR. TOM shall make the selected event record available both at the console and as a file deposited on the TDB.

3.3 VOICE AND DATA COMMUNICATION SUBSYSTEM

The fixed voice radio subsystem and wireless data communication system shall provide for transmission of voice and data to vehicles and reception of voice and data from vehicles while in the TTS service area. The voice radio and data communications subsystems shall function together to support TOM operation, but shall be designed with minimal interdependence, such that a single point of failure shall not disable both voice and data communications. The voice radio system shall continue to operate as a standalone radio system in case of failure of the TOM data system. The wireless data communication system shall not have a single point of failure and shall continue to operate independent of a failure in the voice radio system.

If the Contractor implements a data radio subsystem, that requirements in this specification for an analog data radio equipment shall apply. The analog data radio equipment shall have an upgrade path to digital technology that is defined and currently available in the U.S. and accepted for use by the FCC. TTS will consider digital equipment that meets the overall intent and performance standards of the TOM specifications and is currently in service for transit fleets of a similar size and application at the time that TTS reviews the proposal. TTS will consider alternative voice and data radio configurations such as VoIP or the use of a cellular data network.

3.3.1 Voice Radio Subsystem Interface

The voice radio system shall be configured to operate such that mobiles only hear calls directed to the individual user or group of users. The TOM interface to the radio system shall be via wireline control of the base station with back-up radio control via control stations at each dispatch workstation. .

TOM shall support a "voice fallback" mode of voice communications in the event that normal (data) communications with one or more vehicles has failed, such as during the failure of the data communications system. In the voice fallback mode, two-way voice communications between the TOM dispatch console users and the vehicles affected by the failure shall still be possible. All affected vehicles shall be automatically switched to the fallback mode when a failure of normal communications is detected. Vehicles unaffected by the failure shall continue to operate in the normal communications mode. The time period between detection of a communications failure by a vehicle and the entering of fallback mode shall be adjustable by the system administrator. Vehicles in fallback mode shall periodically check for restoration of normal communications at an interval that is adjustable by the system administrator. When normal communications have been restored, all affected vehicles shall automatically return to the normal communications mode.

During fallback mode, vehicles equipped with silent emergency alarm capabilities shall continue to allow those emergency alarms to be initiated. All such fallback silent emergency alarms shall be immediately annunciated to TOM workstations and shall provide TOM users with at least the vehicle ID of the vehicle that issued the alarm.

The proposers shall describe how their offering will meet this requirement.

3.3.2 Wireless Data Communication Subsystem

Contractor shall implement a conventional data radio system or an alternative wireless data communication subsystem. Coverage shall be provided throughout the required coverage area, defined as Torrance Transit Systems service area, shown in Appendix H. The data communication system coverage shall be equivalent to the voice radio system coverage.

If a data radio subsystem is implemented, the Contractor shall design, deliver, and implement an 800 MHz data radio system. The data channel to be used is a City of Torrance licensed channel pair at 810.96250 and 855.96250 MHz. If the Proposer cannot warrant meeting the coverage requirements for the data radio system if the current site on the license is used, Proposer shall inform the Agency during contract negotiations and shall prepare the applications necessary for TTS to submit to the regional frequency coordinator and FCC to add a site that is recommended by the Proposer to the license. The Proposer shall include costs to obtain, prepare, and acquire leasing for the site recommended by the Proposer.

If a data radio subsystem is implemented, Contractor shall implement a link between the communication controller, located at the TTS facility to the base station at the site. The Contractor shall provide the base station, antenna, and mobile data radio equipment.

The data communication subsystem shall support the RTT, and PRTT data transfer commands. The SAS data transfer commands shall be supported such that the commands shall be sent if either the voice radio or data modem is operational. Voice channels shall not be used for other data transmission, except as approved by Torrance Transit Systems.

The Road Supervisor Subsystems (Option) in the transit supervisor vehicles shall utilize a wireless service provider for data transmissions with the Road Supervisor MDCs.

3.3.2.1 RF Coverage Area and Reliability

Coverage for the data communication system shall be such that at least 95% of the TTS service area, as defined in Appendix H, shall have reliable data transfer in both directions of transmission. If a data radio system is implemented, the RF signal present at the receiver input in a supervisor vehicle shall be sufficient to produce an average bit error rate of less than 1×10^{-4} with 95% probability, with no retries for reliable data transfer while in the TTS service area.

Coverage areas shall be measured and tested by dividing the service area into sectors that are one mile by one mile. Minimum acceptable signal level is -95dBm, unless the Contractor's design shows that their system can operate at a lower level. At least 95% of the sectors shall pass the above stated criteria for TOM to comply with this Specification.

If a data radio system is implemented, the Contractor shall select the radio site, transmitter ERP, and mobile ERP such that these coverage requirements are met, subject to FCC license restrictions. Any site referenced in this Specification is a recommendation only and use of the site shall not relieve the Contractor of responsibility for complying with these coverage requirements. Base station and mobile transmitter powers stated in this Specification shall be the minimum power requirements.

3.4 COMMUNICATIONS CONTROL

The TOM communications control switch shall provide all switching, signaling, and level control to interface all voice radio communications to the dispatch consoles and provide control of the radio resources. The TOM communications control switch provides for intercom communications between consoles. TOM shall interface to two control stations for each dispatch control position, monitor the dispatch PTT and incoming voice radio ID of received calls from field units, and provide an audio recording of radio communications of each radio base station.

3.4.1 Console Communications

All radio transmit and receive audio from each console shall be interfaced to a logging recorder.

The TOM communications control switch provides the audio connections for the lead bus operator's transmit, receive, and monitoring of audio lines to the base station via the existing TTS voice radio system to complete the radio calls, as selected from each dispatch console. The TOM communications control switch generates and decodes required tone signaling to monitor and respond to Push-to-Talk operation from the dispatch control consoles.

3.4.1.1 CAD Interface

Selection of calls by the console user shall be via the Computer Aided Dispatch (CAD) human-computer-interface provided by the console. The console shall be interfaced to the communications control switch directly, or via a dedicated processor, one per console.

3.4.1.2 Data Radio Control

If a data radio system is implemented, TOM shall control all data communications between the fixed equipment and the Onboard TOM subsystems via the data channel.

This control shall be implemented using equipment at the site(s) and corresponding equipment at the TTS facility.

If an alternate data communication system is proposed, the proposer shall describe the method of control for data communications between the fixed equipment and the Onboard TOM subsystems as part of their proposal.

3.4.1.3 Capacities

TOM shall provide for expansion capability to eight dispatch consoles.

3.4.2 Telephone Interface

Contractor shall provide a connection at each dispatch console position that is interfaced with the City of Torrance Transit Systems SV8500 telephone system. All telephone transmit and receive audio from each console shall also be interfaced to the TOM logging recorder. The logging recorder shall provide beep tones to indicate the telephone conversation is being recorded.

3.4.3 Audio Recording

The logging recorder interface shall provide two dedicated channels (one for selected audio and one for unselected audio) for each dispatch console. When a radio, telephone, or intercom call is active, all transmit and receive audio shall be presented to the logging recorder channels assigned to the dispatch consoles as a continuous audio stream (non-trunked).

3.5 COMPUTER SUBSYSTEM

TOM shall provide the features for its administration including, but not limited to, those described in the subsections below.

3.5.1 Archival, Summary, and Restoration of Operating Data

TOM shall manage historical records of events and manually entered data. TOM shall keep at least 90 days of recorded history available for immediate access from consoles. TOM shall automatically initiate archiving of history beyond 15 days to permanent off-line storage, notify the system administrator prior to an archive session and at the completion of an archive session. TOM shall define the labeling and instruct the operator supporting the archiving processes. TOM shall supply tools for transferring TOM data to the Transit Database, and for managing archiving and retrieval of all historical records on the TDB for purposes of reporting. The TOM data shall be organized so that historical records for each fleet shall be stored separately.

3.5.2 Failover and Backup

TOM shall maintain the specified availability and reliability requirements with appropriate redundancy to avoid or minimize any System failures as required to comply with the Agreement and Specifications.

a) TOM shall run Contractor-furnished comprehensive self-diagnostics. When TOM detects unusual conditions or failures, TOM shall notify the system administrator and log the occurrence. TOM shall filter repetitive and cascaded event notices.
b) Where redundant units are designed into TOM, TOM shall detect the failure of operating units and automatically switch to a working spare.
c) The switchover shall be accomplished without disruption of operation or loss of operating data.
d) Return of a repaired unit to service shall be accomplished automatically by its restoration.

3.5.2.1 Security

TOM shall permit access to features only to those people who have presented it with proper identification codes and passwords for those features.

3.5.2.1.1 Access Privilege Assignment

TOM shall define a System Administrator, with the authority to set access privileges, identification and passwords for all other users.

3.5.2.1.2 Dispatch Center User Access

TOM shall limit access to its Dispatch Center Console functions through password controls. TOM shall allow each user to have a unique password. Privileges shall be different for the user groups: Lead Bus Operator, transit supervisor, Senior Business Manager or Transit Operations Manager, and system administrator.

3.5.2.1.2.1 Configuration Management Access

TOM shall permit a System Administrator access to all system functions, including configuration management and control over all other passwords for access. TOM shall allow the system administrator to define password groups and individual passwords within groups.

3.5.2.2 Performance Monitoring

TOM shall contain on-line tools to collect and report performance and resource use information on itself. This shall include TOM processors, TOM LAN, Wireless LAN, data radio (if applicable) and fixed data radio subsystem control equipment (if applicable). Simple Network Management Protocol (SNMP) shall be utilized for monitoring and control of all TOM network, local and wide area network, as well as network elements. All equipment alarms and diagnostic messages shall be presented in a clear, organized, consistent user interface. Equipment alarms shall be reported in real time, including emails and SMS messages to maintenance personnel. Events that affect or may affect the ability of TOM to continue to operate as specified shall be considered alarms. Classification of events as alarms shall be configurable by the System Administrator.

3.5.2.3 Test and Simulation Environment (Option)

TOM shall provide a simulated environment for testing System Components at the Dispatch Center, at radio base station(s), and at buses. The simulated environment shall enable the following:

- Connect to its subject system generally as the real environment connects
- Provide capability of running scripts or accepting requests for specified interactions from the full range of possible interactions between subject System Components and environment, including timing
- Be controllable from any console or workstation that is properly configured.
- Be capable of performing all functions that TOM is expected to perform.
- Be capable of operating while the normal TOM is in operation, though the simulation operational set maybe a subset of the normal TOM.
- Contain sufficient diagnostics to determine an operational normal probability (Gaussian) confidence level of all equipment operating in the simulation environment.

3.5.2.4 Remote Diagnostics

A port shall be provided for remote access to TOM for diagnostics and trouble resolution. Access shall be restricted through multiple levels of security, including dial-back only

connection. Security provisions for this port shall be configurable. All transactions on this port shall be logged.

3.5.3 TOM System Software

The Contractor shall provide complete software to support all TOM functionality.

3.5.3.1 Dispatch/Custom

- Contractor shall provide interfaces to and between various manufacturers' software packages through industry standard APIs.
- Contractor shall furnish the complete software, instructions, and data to re-build TOM.
- The control software shall be modular in design and shall be easily configurable by TTS staff.

3.5.3.1.1 Off-the-Shelf Operating Systems

All TOM servers shall use the same server operating system. All TOM workstations shall use the same PC operating system. Network operating software shall be part of the provided operating system product. At a minimum, the Contractor shall provide software for Dispatch Center equipment that shall include the following:

- Operating system / network operating system
- Graphical user interface
- Network management system
- Database management system, including scheduled archiving and updates, and restoration
- Forms package, report package, and query package
- Tools to edit, debug, generate and reproduce executable code from the source code
- Software configuration management package
- Software performance monitoring and reporting tools (that portion not specific to the application)
- Equipment diagnostic software
- Virus detection and protection
- Firewall to protect against unauthorized database updates or accesses resulting in performance degradation

The operating system software shall meet the following requirements:

- Be commercially prevalent or industry-standard system software
- Have training available from one or more manufacturer-approved training groups/companies in the Los Angeles area
- Have technical support available for purchase from the software manufacturer and/or distributors

3.5.3.2 Wide Area Networking

The Contractor shall extend the TOM LAN at the Dispatch Center to the voice radio and data communication system network utilizing industry standard wide area networking (WAN) hardware.

The Contractor shall configure TOM LAN to be fault tolerant. In cases when the primary communications path fails, data communications on the WAN shall automatically utilize a secondary path.

Commercially available bridges, switches and routers shall be utilized. Standard IP addressing shall be utilized. All equipment shall be managed using Simple Network Management Protocol (SNMP) from the TOM System administrator workstation. The WAN connection shall provide for forwarding of SNMP for management of LAN hardware at Torrance Transit Systems facility from the TOM System administrator workstation.

3.5.4 AVA Database Editor Workstation (Option)

TOM shall provide a workstation for updating the database utilized for AVA, including the recording of new digitized audio, application of the audio to the correct stop, application of the location of the tripper point for the audio announcement to the AVA database, and a tool to add, change, or delete messages, routes, and stops. The workstation shall allow use of a headset microphone or a CD as the audio source.

3.5.5 Multi-Channel Digital Voice Recorder

A logging recorder with capacity for twelve analog audio channels shall be provided. The new logging recorder shall be networked via Ethernet TCP/IP interface. All recorder controls and playback shall be available from a single user interface via the Ethernet connection.

3.5.5.1 Recorder Capabilities

The recorders shall use DVD RAM disks as the long-term storage medium with temporary storage on hard drive. Up to 500 hours of audio shall be stored per DVD with compression of each channel to 6.3 kb/s as per ITU Standard G723.1. One DVD-RAM drive shall be provided for twelve audio channels. Instant access retrieval from hard drive storage shall also be provided. Audio shall be indexed with date and time stamps. Voice activated recording shall be used to minimize recording of idle channels, however the recorder shall be capable of DTMF-detect, ring-detect, off-hook-detect, and contact closure triggers and continuous recording. The recorder shall utilize a real-time multi-tasking operating system. Audio file type shall not be compatible with common multi-media software. Mean time between failures for each recorder shall be at least 15,000 hours. Recorder units shall be rack mounted.

3.5.5.2 User Interface

A PC user interface shall be provided for control and monitoring of audio, connected to the recorders via Ethernet, using TCP/IP. Transfer of audio files shall be secure. The user interface shall utilize a separate hardware set, not the on-line recorder hardware. The user interface hardware set shall include a DVD-RAM recorder for making copies. All software for control and playback shall be provided, including the operating system. Management of individual channel assignments shall be provided. Playback and search features by date and time shall be provided. Searching for calls across multiple recording devices shall be allowed.

The PC user interface shall be equipped as recommended by the recorder manufacturer. The PC shall use the most current commercial technologies for the processor, RAM and hard drive memory, video and audio cards. The PC provided shall include a standard keyboard, optical mouse, speakers, and 19" minimum color LCD monitor with resolution representative of current commercial technologies and approved by TTS.

3.6 AUTOMATIC VEHICLE LOCATION

The automatic vehicle location subsystem shall provide real-time vehicle location updates for use by the onboard subsystem for vehicle location reporting, route and schedule adherence, automatic passenger counting (if APC option is exercised), and automatic vehicle announcements (if AVA option is exercised). The subsystem shall also provide velocity, time, and direction of travel information. TOM shall retain and store all AVL information in a database.

The AVL subsystem shall utilize GPS technology and shall apply Wide Area Augmentation Signal (WAAS) differential correction to the GPS signal. The AVL subsystem shall utilize a dead-reckoning algorithm with odometer interface for vehicle location when the GPS signal is unavailable. Use of gyros for the dead-reckoning is preferred.

3.6.1 Location Accuracy

TOM shall locate vehicles within five meters and shall have the accuracy necessary to support AVL-related functions. This accuracy includes not only the raw position solution in latitude and longitude, but also the accuracy of the GIS database.

3.6.1.1 Support for AVA (option)

TOM shall provide necessary accuracy for AVA activation within two seconds of the stated times for triggering announcements.

3.6.1.2 Support for Stop Correlation

TOM shall provide for correct correlation of passenger counts and fare transactions to the correct stop with 99% probability.

3.6.1.3 Support for Off-Route Determination

TOM shall provide for off-route notification when a bus is traveling on a parallel street separated by more than thirty feet from the route with 99% probability.

TOM shall falsely report a bus as off-route (more than thirty feet from the defined route locus) with probability for less than 0.01% of all off-route notifications.

3.6.1.4 Support for Graphic Displays

TOM shall place the location of the bus icon on the correct street with 99.9% probability. Icons shall be placed in streets and shall not be displayed in the middle of a block or off-road, unless the bus has actually left the road.

3.6.1.5 Support for Yard Positioning

TOM shall correctly correlate buses to locations in line in the bus yard with 99% probability of accuracy.

3.7 ROUTE SCHEDULE ADHERENCE

3.7.1 Support Schedule and Route Adherence

TOM shall supply information to bus operators, lead bus operator, and transit supervisors as needed to assist with schedule adherence, and schedule deviation recovery.

3.7.1.1 Determine Location

In addition to providing location information to the lead bus operator, transit supervisor, maintenance personnel and Torrance Transit Systems management; the location information shall be utilized to calculate route and schedule adherence, to trigger stop announcements, to correlate APC data to stops, and to predict time of arrivals.

3.7.1.2 Route and Schedule Database

Contractor shall provide an up-to-date, accurate route and schedule database and tools to update the route and schedule database. The tools shall include a GIS tool for the route database and a tool to electronically import TTS generated updated schedules, routes, and bus stop listings. TOM shall store and maintain a copy of the current systemwide route and schedule in the Onboard TOM equipment. Updates to this database shall be accepted via the wireless LAN and via the data radio. Downloads of new versions of the database shall be via

the wireless LAN. Complete version control of the database and validation shall be provided.

3.7.1.3 Schedule Adherence

TOM shall determine and display to the bus operator the current time deviation from schedule for the assigned run, including late pullout status.

TOM shall report this status to the Dispatch Center, if the schedule deviation is more than a pre-defined threshold early or late. The thresholds shall be selectable at the Dispatch Center for each route and run.

TOM shall have a means for the Dispatch Center to provide changes to the thresholds to the Onboard subsystem, or to disable reporting of schedule adherence for an individual bus, or for all buses on a route.

TOM shall determine times for stops, dwell times at stops, start of assignment, pull-ins, pull-outs, start of trip, layover on assignment, end of trip, and end of assignment and shall report deviations.

3.7.1.4 Route Adherence

TOM shall provide the operator with a brief, distinctive audible warning sound if the bus is off route, further than a pre-defined threshold, and shall display the name of the next stop on the defined route. The off-route status shall also be transmitted to the Dispatch Center. The off-route threshold distances shall be selectable at the Dispatch Center for each route. A default threshold distance for the fleet shall be settable by the TOM System administrator. TOM shall have a means for the Dispatch Center to provide changes to these thresholds to the onboard subsystems or to disable reporting of route adherence for an individual bus, or all buses on a route.

3.7.1.5 Display Time

TOM shall normally display the current time for the operator using the onboard subsystem MDT. This display can be superceded by other information as required for efficient operator interface, but shall return to display of time when the superceding information is no longer required to be displayed.

Time shall be determined based on GPS time and shall be displayed in twenty-four hour format for Pacific Standard Time or Pacific Daylight Time. TOM shall provide for automatic correction for daylight saving time. The onboard subsystem shall maintain time, if the GPS signal is lost to within 10 seconds per month of drift. When the onboard subsystem is receiving a GPS signal, the time displayed on the MDT shall be within one second of the time displayed on the CAD consoles.

3.8 ONBOARD SUBSYSTEM

3.8.1 Description and Functional Overview

3.8.1.1 Power-up and Power Down

TOM shall accept the vehicle status as active when the bus is powered up and inactive when the bus is powered down. The powered up status for that bus shall be retained by TOM. In addition, the Onboard TOM subsystem equipment shall remain active when the bus is shut off at a layover.

TOM shall send to each bus the operator and run information for its next assignment. TOM shall require a bus operator or maintenance personnel to logon to a bus before accepting any other request through its MDT. The bus operator shall be prompted to enter his/her correct operator ID and correct work assignment. TOM shall accept the data, provide notification to the operator that this information was accepted, and provide indication of whether the information entered is as expected or not.

TOM shall accept an operator command to logoff, thus making the onboard subsystem ready for a new logon.

TOM shall maintain an "uncorrelated" state for any bus that is powered on but without an operator logon that corresponds to its next assignment. Lead bus operators shall have the ability to correlate assignments.

3.8.1.2 Manage Radio Calls

TOM shall provide support to manage radio calls and messaging as described below. TOM shall provide the bus operator with status messages of the radio and data system on the MDT.

3.8.1.2.1 Receive and Annunciate Calls from Dispatch Center

The onboard subsystem shall receive radio calls initiated at the Dispatch Center, from a Road Supervisor System, or from a portable radio and make an audible and visual annunciation that a call is pending. The annunciation shall indicate the call type. All selection and switching of talkgroups shall be transparent to the users.

3.8.1.2.2 Individual Calls

In the normal mode of operation, TOM shall only allow the bus operator to hear voice calls after sending a RTT or PRTT, and receiving a call back from a lead bus operator or transit supervisor. TOM shall allow the bus operator to receive each pending call by removing the handset from the cradle, communicate by utilizing the handset push-to-talk, and terminate the call by returning the handset to the cradle.

3.8.1.2.3 Group Calls and All-Calls

TOM shall alert the operator and shall route the audio to the monitor speaker. The operator shall have the option of lifting the handset to receive the audio, at which time the audio to the speaker shall be disconnected. The handset push-to-talk shall not be active. Call termination shall be controllable by console action at the Dispatch Center. Non-emergency calls shall time-out if there is no activity on the radio channel for a system administrator settable time.

3.8.1.2.4 Receive and Annunciate Messages from Dispatch Center.

The Onboard TOM subsystem shall accept text messages sent from the Dispatch Center and display those messages to the bus operator. The Onboard subsystem shall make an audible and visible annunciation when an unacknowledged text message has been sent to a bus operator. The Onboard subsystem shall allow for the reading and acknowledgement of messages received from the Dispatch Center. TOM shall report to the Dispatch Center the acknowledgement of text messages by the bus operator. The Onboard subsystem shall allow the operator to clear a text message display after it has been acknowledged.

3.8.1.2.5 Accept Calls to Dispatch Center

In the normal mode of operation, TOM shall only allow a bus operator to call a lead bus operator at the Dispatch Center or transit supervisor, by selecting either the normal priority request-to-talk (RTT) or high priority request-to-talk (PRTT) button on the MDT. TOM shall give an audible and visible annunciation that a request to initiate a call has been received at the Dispatch Center and queued within 30 seconds. When the call is accessed at the Dispatch Center, TOM shall process the call as described above for individual calls. In the normal mode of operation, TOM shall accept a bus operator cancellation of a request to initiate a call to the Dispatch Center and shall remove the pending call from the call queue at the Dispatch Center.

3.8.1.2.6 Accept Messages to Dispatch Center

TOM shall accept requests by the bus operator to send an operator-selected text message from a set of text messages. The available messages shall scroll on the MDT display for selection by the operator. TOM shall send and process the selected text message similarly to an RTT, except that a return call to the bus is not required when the message is accessed at the Dispatch Center.

3.8.1.3 SAS

TOM shall accept a silent alarm system (SAS) request activated from a covert switch on the bus. When the SAS is activated, TOM shall cause this status, the vehicle ID, and current location to be immediately sent to the dispatch console that is assigned to monitor that bus. TOM shall command the onboard video system to record in high resolution mode and the covert mic shall be activated for continuous audio, while the SAS is active. The SAS activation shall be discreetly displayed onboard the bus and shall cause the exterior headsigns to display an emergency message. TOM shall provide the current vehicle location to the Dispatch Center every fifteen seconds while the SAS is active. When the responsible console user acknowledges the SAS, TOM shall send an acknowledgement notification to the bus operator within fifteen seconds. TOM shall display the acknowledgement notification to

the bus operator using a discreet unlabeled light or unlabeled screen symbol on the MDT display.

All incoming calls, messages, audible alerts, etc. shall be disabled while an SAS is active. The SAS status shall return to normal upon activation of a call request (RTT, PRTT).

3.8.1.3.1 Test SAS

TOM shall provide an automatic in vehicle self test of the SAS switch at startup.

3.8.1.4 Radio Fallback Operation

TOM shall support operation of voice radio communications and SAS functionality in the event of a TOM data mechanism or TOM processor failure. The voice radio shall operate on a default talk group.

3.8.1.5 Report Data to Dispatch Center

TOM shall report automatically collected and manually entered data to the Dispatch Center, as defined below.

3.8.1.5.1 Bus Mechanical Status

TOM shall automatically report to the Dispatch Center changes in status of bus alarms. These status changes shall be entered into call queues at the Dispatch Center with the same priority as a PRTT. Reporting of mechanical alarms shall be disabled for a selectable period following start-up to prevent false reporting. Status changes shall have occurred for a period of at least two seconds to be considered a valid alarm for reporting. The Senior Business Manager or Transit Operations Manager in the dispatch center and the equipment supervisor in the maintenance area shall have the capability to disable and re-enable reporting of individual mechanical alarms on each bus. Alarm messages shall not be sent when disabled.

3.8.1.5.2 Operator-Selected Status

TOM shall accept operator-selected status, including in/out of service, at scene, out of vehicle, clear, on break, on special assignment and return to normal. These messages shall not be entered into call queues or automatically displayed, but shall be retained by TOM for use in case a dispatch console user attempts to contact the vehicle or operator. A convenient means of selecting these messages shall be provided such as a selectable scrolling list on the MDT display.

3.8.1.5.3 Bus Collected Data

Changes in passenger counts, wheelchair actions, and fare box alarms, shall be obtained from existing and future onboard systems via serial interfaces RS-232, SAE-J1708, and SAE-J1939. TOM shall retain this data onboard the bus and report it to the Dispatch Center as requested, or as scheduled. This data shall be scheduled to be downloaded at the end of revenue service when the bus is in the bus yard. The location of the bus and the time when

the condition occurred shall be recorded with the event. Time used for data recording shall be synchronized to GPS time.

3.8.1.5.4 Vehicle Location, Schedule and Route Adherence

TOM shall report current bus location, along with bus identification, to the Dispatch Center with all status messages. TOM shall also solicit location updates from powered-up buses at least every minute, if no other messages from the bus have occurred. The Onboard subsystem shall respond to these queries with the current location and bus identification.

3.8.1.5.5 TOM Equipment Status

TOM shall monitor the status of all Onboard TOM components to detect failures, disconnected equipment, or missing equipment. Detected failures shall be retained onboard the bus and reported to the Dispatch Center in real-time, as requested or as scheduled. This data shall be downloaded at the end of revenue service when the bus is in the bus yard. The location of the bus and the time when the condition occurred shall be recorded with the event. Time used for data recording shall be synchronized to GPS time.

The type of reporting (real-time, as requested, or as scheduled) shall be selectable for each piece of Onboard TOM component.

3.8.1.6 Headsign Control

TOM shall control existing headsigns that are capable of electronic control, such that the headsign display corresponds to the operator's work assignment, “Special Run” or “Out of Service” status. Top and side mounted destination signs shall also be controlled.

TOM shall provide capability to control run number signs, should Torrance Transit Systems procure buses with controllable run number signs. TOM shall not interfere with the manual operation of the destination signs nor degrade their performance.

3.8.1.7 Automatic Passenger Counters (Option)

TOM shall collect passenger boarding and alighting counts and correlate the counts to stops, lines, and runs as further described in Section 3.8.2.

3.8.1.8 Automatic Voice Annunciator (Option)

TOM shall provide passenger information via audio and visual announcement of stops via control of electronic sign displays as further described in Section 3.8.3.

3.8.1.9 Video Security System (Option)

TOM shall interface to the existing onboard video security system (VSS) to provide GPS time updates and command the VSS to tag video data during an SAS. TOM shall upload video data via the wireless LAN at the bus yard.

3.8.1.10 Vehicle Health Monitoring (Option)

TOM shall interface with existing sensors and onboard processors for acquisition of vehicle health status information. This data shall be reported to the Dispatch Center and uploaded at the Yard Workstation, as further described in Section 3.8.5.

Additional functionality, such as the capability to update the engine dispatcher software is desired. Proposers shall describe how their offering can meet this requirement.

3.8.2 Automatic Passenger Counters (Option)

3.8.2.1 Functions

The Automatic Passenger Counters (APC) subsystem shall be capable of providing, at a minimum, the following passenger count information:

- Number of passengers boarding and alighting by doorway at each door open/close correlated to a schedule line, run, trip, stop name, and schedule time
- Number of passengers onboard by segment, run and line
- Number of wheelchair lift/ramp cycles at each stop the bus makes for each run and trip on a line
- Number of wheelchair passenger boardings and alightings at each stop the bus makes for each run and trip on a line
- Location (stop name or coordinates), time and date for each boarding and alighting, start of trip and end of trip
- Bus number
- All door open/close cycles for each stop with a time stamp. The first door open shall be correlated as the arrival and the last door close as the departure
- Counts of door open and close cycles at unscheduled locations or detours
- Passenger miles by segment, run, route, day—Passenger miles are the cumulative sum of the distances ridden by each passenger. A segment is a section of a run between two stops.
- Average passenger miles by segment, run, route, day
- Total passenger boardings by segment, run, route, day
- Dwell time at each stop—Dwell time is calculated from the first door open to last door close at a stop.
- Distance traveled between stops
- Pull-in and pull-out times at yard entrance and at layover zones—even if there is no door open/close at these locations
- Designation of off-route operation for inter-lining or deadheading

The APC subsystem shall at a minimum, provide the following:

- Provide accurate passenger accumulated count data. The accumulated count of alighting passengers shall be within 5% for each 1000 consecutive boarding and alighting passengers, and the accumulated count of boarding passengers shall be within 5% for each 1000 consecutive boarding and alighting passengers.
- Provide accurate stop-by-stop count data. For 85% of all door cycles, the boarding and alighting counts shall be exact when compared to actual. For 90% of the stops, the counts shall be within one passenger of actual. For 97% of the stops, the counts shall be within two passengers of actual. This shall include stops for which there was no observed boarding or alighting activity. Counts from multiple door openings near a stop shall be correlated to that stop.
- Correlate passenger counts to the correct run if TOM cannot correlate the counts to a stop
- Calculate passenger miles for passenger boardings and alightings at unscheduled stops
- Provide accurate location. For 95% of the time, TOM shall correctly identify a bus scheduled stop. For 97% of the time, TOM shall correctly identify a scheduled bus stop or an adjacent scheduled bus stop for the bus run. Only stops where there is a door opening/close shall be included in this calculation.
- Provide accurate passenger counts such that the onboard passenger count shall not change from one segment to another when there is no door open/close between the segments.
- Store and retain onboard fourteen days of recorded APC data.
- Store and warehouse all APC data collected for five years in an APC database.
- Perform a verification of the download from the onboard processor to the TOM Server.
- Provide valid and accurate data (95% accuracy with a +/- 5% confidence) for the generation of NTD reports.

3.8.2.2 On-Board Processor

The APC subsystem shall use the Onboard TOM Processor directly or indirectly, using a sensor controller, to determine, record and store data received from the sensors, GPS receiver, spread spectrum radio, and dead reckoning system. Stored passenger counts shall be correlated to a stop in the Onboard Processor and stored with the time.

3.8.2.3 Vehicle Location

The APC subsystem shall use the AVL subsystem to determine the bus location, and stop, whenever there is a door cycle or there is a stop exceeding a system administrator-settable number of seconds. The Contractor shall submit for TTS approval calculations showing the expected correlation of passenger counts to the correct stop <CDRL>.

3.8.2.4 Wireless LAN Download

The APC subsystem shall use the wireless LAN subsystem to download passenger count data from the buses and to upload new schedule and route information to the buses while at the bus yard.

3.8.2.5 APC Data Processing

Collected APC data shall be processed in order to ensure that the data is properly correlated to bus stops and that the data is statistically valid for use in NTD reports and for planning purposes. This processing shall include removal of clearly erroneous data, such as may occur from sensor failures.

The processing shall also remove data for buses that would otherwise improperly affect statistical results for monitored bus routes due to temporary and unanticipated changes to the operation of buses on those routes. Changes of this type to be detected shall include, but not be limited to, significant off-route operation, significant off-schedule operation, breakdowns, and unscheduled turn-backs. Parameters for determining various filtering thresholds required by the processing shall be definable by the system administrator.

3.8.2.6 APC Accuracy

The Contractor shall submit for Torrance Transit Systems approval an analysis and calculation of the APC subsystem accuracy from data collected during an APC verification test <CDRL>.

Boarding and Alighting accuracy shall be calculated as follows:

$$\text{Boarding Accuracy} = (\text{Boardings}_{MANUAL} - \text{Boardings}_{APC})/\text{Boardings}_{MANUAL}$$
$$\text{Alighting Accuracy} = (\text{Alightings}_{MANUAL} - \text{Alightings}_{APC})/\text{Alightings}_{MANUAL}$$

The Contractor shall perform a one year manual count (or actual ride along surveying) to verify the accuracy of the APC system and APC data, required by the FTA to certify the APC subsystem.

3.8.3 Automatic Voice Annunciators (Option)

3.8.3.1 Functions

The AVA subsystem shall provide for automatic annunciation of each stop in both audio and visual formats. Based on the block assignment and the current location as determined by the AVL subsystem, the AVA subsystem shall calculate when to make an announcement at a pre-defined location in advance of each stop. The AVA subsystem shall provide accurate announcements—for 99% of the time, the AVA subsystem shall correctly identify a bus stop and make the correct announcement. Assuming that the correct block assignment has been entered into the AVA subsystem and the bus is on-route, no driver action will be required for AVA operation. Operators shall not be able to disengage AVA operation.

3.8.3.2 Announcements

All stops shall be announced. When the bus is approaching a stop, one announcement shall be made for the next stop. The distance from the stop when the announcement is triggered shall be selectable by stop and direction or applied globally and will be stored in the route and stop database residing in the onboard processor.

The AVA subsystem shall allow, through the PA microphone, instant operator-voice override for emergency or priority announcements. The voice override shall automatically time-out after 30 seconds. The override shall be reported as an event.

The AVA subsystem shall make ambient noise measurements to provide independent, automatic volume control for internal and external announcements. Audio levels shall be controllable by the vehicle operator within a usable audio range.

The Contractor shall provide the audio files for all announcements. Each audio announcement shall be up to 30 seconds in length and shall include the stop designation such as the complete intersection name or landmark name. Contractor shall submit for TTS approval sample tapes of the audio. The audio files shall be recorded in a manner that would allow TTS to easily truncate or append announcements.

AVA shall provide text announcements that correlate to each audio announcement, utilizing the onboard LED signs. The Contractor shall submit for TTS approval the exact text to be used for each stop announcement. <CDRL>

The Contractor shall provide the capability to make the following additional announcements:

- X ft. after leaving the stop, where X is adjustable
- At Y minute intervals, where Y is adjustable
- When the bus arrives at the stop, TOM shall make announcements using an exterior speaker providing the bus line number and destination. The exterior announcements shall be disabled during the night and early morning hours. The hours when the exterior announcements are disabled shall be a system settable parameter.

The location of the announcements shall be selectable by direction and stop and shall be stored in the stop database residing onboard.

Stop announcements shall be of the following types:

Location	Interior Announcement	Exterior Announcement
In Advance of Stop	Next Stop <Street Name 1> and <Street Name 23> (Audio and Visual)	None (Audio) Destination (Visual)
In Advance of Stop	Next Stop <Landmark Name> (Audio and Visual)	None (Audio) Destination (Visual)
In Advance of Stop (Express routes)	Destination < Destination Name> (Audio and Visual)	None (Audio) Destination (Visual)
Leaving Stop	Next Stop <Street Name 1> and <Street	None (Audio)

	Name 2> (Audio and Visual)	Destination (Visual)
Leaving Stop	Next Stop <Landmark Name> (Audio and Visual)	None (Audio) Destination (Visual)
Leaving Stop (Express routes)	Destination <Destination Name> (Audio and Visual)	None (Audio) Destination (Visual)
At Transfer Point Stop	This Stop <Street Name 1> and <Street Name 2> (Audio and Visual), Transfer Point for Line Numbers <Numbers> or This Stop <Landmark Name> Transfer Points for Line Numbers <Numbers>	Line Number <Number>, Destination <Destination Name> (Audio) Destination (Visual)
At Stop	This Stop <Street Name 1> and <Street Name 2> (Audio and Visual)	Line Number <Number>, Destination <Destination Name> (Audio) Destination (Visual)
At Stop	This Stop <Landmark Name>	Line Number <Number>, Destination <Destination Name> (Audio) Destination (Visual)
At Stop (Express routes)	Destination <Destination Name> (Audio and Visual)	Line Number <Number>, Destination <Destination Name> (Audio) Destination (Visual)

As an option, TOM shall be capable of repeating audio and text stop announcements.

3.8.3.3 Route Deviations

If the bus goes off-route, announcements shall not be made until the AVA subsystem determines that the bus is again traveling on the assigned route.

In the event of an interline, where a bus switches from one line to another, the system shall continue to make the correct announcements.

If a stop is bypassed, the correct next stop announcement shall be made. If an unscheduled stop is made, the AVA subsystem shall not interpret this as the actual stop, unless it occurs within the position accuracy of the AVL. Correct next stop announcements shall continue.

If the bus status is changed to out-of-service through an operator log-in, announcements shall be inhibited, except that the headsigns shall display “Out of Service”.

3.8.3.4 Other Announcements

AVA shall display a time and operator badge number text announcement periodically.

AVA shall make public service and advertising audio and text announcements periodically or at pre-defined locations. Appendix E provides partial list of public service announcements that shall be provided.

The operator shall have the capability of manually selecting from a menu of predefined messages for announcements to passengers that may override an automatic announcement; however, operators shall not be able to disable initiation of audio announcements.

AVA shall make audio and visual "Stop Requested" announcements. The Stop Requested display shall be cleared when a door is opened.

3.8.3.5 Stop Announcement Database

The Onboard TOM equipment shall store the full TTS stop database and corresponding audio and text message database.

Modifications to this database shall be provided via the wireless LAN at each bus yard. The current version of the database shall be made available by the Onboard TOM equipment when queried via the wireless LAN. Changes to the database shall be accepted without requiring a complete download of the database each time a modification is made.

Dedicated hard drive storage shall be provided for the audio database onboard each bus. The database shall be structured to avoid pauses or delays in announcements and to minimize wear.

3.8.4 Video Security Subsystem Interface (Option)

TOM shall provide GPS time sync updates to TTS' Mobile View 5 video systems and support wireless downloads of video stored onboard. Proposers shall provide a detailed describe of the interface and where this interface has been previously implemented.

3.8.5 Vehicle Health Monitoring (Option)

3.8.5.1 General Description

The Vehicle Health Monitoring (VHM) subsystem shall monitor the functionality, performance, and operation of onboard equipment that is equipped with a programmable controller for operator-controlled functions and indications. The VHM subsystem shall be capable of collecting, storing and transmitting health and diagnostic data from the equipment via physical wiring, the data radio and wireless download. Key mechanical alarms shall be

transmitted to the dispatcher via the data radio immediately upon detection of the alarm. TOM shall automatically create VHM reports and archive VHM data in the TOM Database.

3.8.5.2 Equipment Monitored

The VHM subsystem shall be designed to be flexible such that it can function with any mobile equipment that is equipped with a programmable controller and a SAE J1587/J1708 or SAE J1939 communications link. The VHM subsystem shall also be capable of communicating with devices using the NTCIP Standard 1400 through 1408 protocols. The VHM subsystem shall be capable of functioning with all existing mobile equipment and any new equipment that Torrance Transit Systems may acquire, provided that the equipment meets the above criteria. At a minimum, the VHM subsystem shall interface with and monitor the following pieces of equipment:

- All Onboard TOM subsystems
- Electronically-controlled natural gas engines that are listed in Appendix D
- Electronically-controlled transmissions that are listed in Appendix D
- Multiplex systems used by TTS and selected equipment--doors, wheelchair lifts, lights, etc.--that are interfaced with the multiplex system.

3.8.5.3 Data Collected

The VHM Subsystem shall be capable of accessing, collecting and storing any data available from the programmable controller through the communications link, including diagnostic and indication data.

For each piece of equipment monitored either directly by VHM or indirectly through the multiplex system, the Contractor shall identify all indications for which a road call is required. The data streams that may provide indications of critical importance, per manufacturer's recommendations, shall be monitored continuously by the VHM.

At a minimum, the VHM subsystem shall record the following parameters:

- Engine Temp.
- Transmission Temp.
- Engine Oil Press.
- Transmission Pressures
- Turbo Boost
- Fire Alarms
- A/C status
- Charging system
- Vehicle speed
- Air System Status
- Throttle position activity
- Brake position activity
- Inter-Lock Status

3.8.5.4 Data Transmission and Output

Indications of critical importance shall be provided for display at two locations:

- Onboard MDT
- Dispatch Center via the data radio subsystem.

All data collected by the VHM subsystem shall be made available to:

- TOM servers and TDB via the wireless LAN system.
- A laptop computer via wireless download.

If proprietary gateways or translator boxes are required, the Contractor shall provide any such hardware and software needed to translate the data into a format that can be read and manipulated by applications currently in use at TTS.

At a minimum, the VHM subsystem shall transmit the following alarms:

- All Farebox issues
- Headsign Status
- W/C Lift
- Engine Temp (when the light goes on)
- Charging System
- Fire Alarms
- A/C status
- Silent Alarm Signal
- Air System Status
- Inter-Lock status
- Door(s) Position
- Low coolant
- High exhaust temp.

3.8.5.5 Design Submittal

The Contractor shall submit a design proposal for the VHM subsystem that includes but is not limited to the following information <CDRL>:

- The specific pieces of equipment to be monitored by VHM
- Identification of the critical data that will be transmitted to the bus operator indication panel and the dispatch consoles
- For each piece of mobile equipment, the data monitored by the VHM subsystem
- Data outputs
- Description of software required
- Equipment and wiring diagrams

The Contractor's proposed design for the VHM subsystem shall be approved by TTS as required in the Specifications and Agreement.

3.9 YARD SUBSYSTEM

A portion of the daily TOM operations shall occur at the Bus Yard. The role of the TOM Yard Subsystem shall be to facilitate and manage data transfer between buses and the Dispatch Center. These operations shall include the following:

- Download of route and schedule adherence from bus
- Download of passenger counts from bus
- Download of video data from bus as required
- Download of Vehicle Health Monitoring System data from bus
- Upload of route and schedule and other database updates to bus
- Display and reporting of bus mechanical alarms, Onboard TOM equipment alarms, and other events requiring maintenance action. TOM shall provide for the creation of work orders related to these items.
- Option: Location of parked buses
- Option: Assignment of operator to bus
- Option: Assignment of bus to run

To perform these operations, the Yard Subsystem shall include the following:

- TOM Yard Server/Workstation
- Interface to TOM LAN
- Wireless Spread Spectrum Access Points

3.9.1 Operator Assignments Option

TOM shall receive next day's assignments of operators to lines and make this available at the Dispatch Center and Yard workstations.

3.9.1.1 Accept Assignments

TOM shall accept and display operator assignment data for the operating day and accept modifications to those data. TOM shall accept creation of unscheduled operator work assignments. TOM shall accept cancellations of operator assignments.

3.9.1.2 Report Assignments

TOM shall produce reports of current operator assignments and logs of changes made to assignments.

3.9.2 Record and Report Bus Location and Bus Actions Option

TOM shall determine and record bus ID, location, and sequence as they are parked in the bus yard. TOM shall produce reports of bus yard locations, available buses, unavailable buses, and assignments of buses to operator/line for the supervisor to use in managing equipment assignments.

TOM shall record movements of a bus in, out of, and within a yard. TOM shall be able to record actions taken upon a bus at each of several work location, including fueling and maintenance, and times to or from those locations. TOM shall produce reports on movement and actions, including logs for buses and summaries by work location.

Proposers shall describe the method by which this is to be accomplished in the proposal.

3.9.3 Bus Assignments Option

TOM shall maintain a yard plan, showing the current bus locations, IDs, availability status, and assignments of buses to operators and work assignments. This plan shall be made available in graphical format on the TOM workstations to the Dispatch Center and yard personnel.

TOM shall make bus assignments based upon the next bus available in a preferred bus series at a ready line at least sixty minutes prior to the time the operator is ready and scheduled to pull out. TOM shall accept a list and changes to the list of preferred series for each line. TOM shall select the first available bus in the highest available preferred series to assign to the line/operator and present that selection at the Dispatch Center and Yard Workstation. TOM shall also be able to make assignments based only upon pullout schedule.

TOM shall accept assignments of buses to unscheduled work assignments. TOM shall automatically assign buses to unscheduled work assignments.

TOM shall accept the holding of bus assignments by the Dispatch Center or Yard workstation. TOM shall send an alert to the Dispatch Center and Yard workstation if a pullout is not made within a settable time after it is due. TOM shall update all necessary locations after changes have been made and ensure that all TOM components that may require this information have access to the updated information.

3.9.4 Wireless LAN

TOM shall include Access Points (APs) to exchange data with the Onboard TOM subsystems while the buses are in the bus yard. The Access Points shall provide adequate radio coverage to allow downloading and uploading of data to the buses in 95% of the bus yard and maintenance areas. (Refer to Site Maps in Appendix F.)

A wireless network management tool shall be provided. The tool will be used to monitor and maintain the wireless system. It will have the capability to log a client on and off of the system and put the client into a maintenance test mode. This tool shall provide reports on

wireless client status, fault indications, log of files uploaded and downloaded to the vehicles, and last login with the AP. If there is an interruption in the download to a vehicle, the download shall be resumed without a requiring a complete redownload of the file.

3.10 SUPERVISOR SYSTEM (OPTION)

TOM shall provide functionality for transit supervisors in supervisor vehicles to manage fleet operations. Supervisor vehicles equipped with the Supervisor subsystem shall enable transit supervisors to have voice and data communications with dispatchers. Transit supervisors shall be able to call other transit supervisors and buses directly with their portable radio.

In addition, the Supervisor subsystem shall include the AVL subsystem, Onboard TOM Processor, voice radio, data modem, spread spectrum radio, and MDT that are installed on the transit buses. TOM shall track the supervisor vehicle locations and classify them as a non-revenue vehicle.

3.11 ROAD SUPERVISOR SYSTEM (OPTION)

TOM shall provide functionality for transit supervisors in field vehicles to manage fleet operations. Supervisor vehicles with Road Supervisor Systems shall have voice communications and data communications with lead bus operators and other transit supervisors. In addition, supervisor vehicles equipped with Road Supervisor Systems shall have full AVL and Onboard TOM Processor capabilities similar to transit buses. TOM shall track the supervisor vehicle locations as a non-revenue vehicle.

The Road Supervisor Subsystem shall include a Mobile Data Computers (MDC) to enable the transit supervisor access to TOM information similar to the information provided at Dispatcher Consoles and to perform dispatching duties from the supervisor vehicle.

TOM shall enable supervisors in Road Supervisor Subsystem equipped vehicles to:

a) Initiate voice calls to buses, other transit supervisors, and dispatch consoles.
b) Call selection from call queues.
c) Receive calls from dispatch console users, other supervisors, and buses (Request to Talk).
d) View notification of any SAS, with street location and operator identification.
e) View and modify any Incident Report assigned from a dispatch console, or create a new Incident Report.
f) Send standard and ad hoc text messages to a bus or selected group of buses, and to the Dispatch Center.
g) Display the street location of selected buses, based upon location, and the status of those buses.
h) Display the street location of another field unit, based on user-defined security restrictions.

The vehicles with Road Supervisor Systems shall also be equipped with voice radio, data modem (if necessary), Onboard Processor (if necessary), spread spectrum radio, and DGPS receiver.

TOM shall have the capacity to handle 300 messages per hour total inbound and outbound.

The supervisor vehicles and maintenance trucks that are not equipped with Road Supervisor subsystems shall be equipped a Supervisor System that includes a voice radio, data radio, MDT, Onboard Processor with spread spectrum radio, and WAAS enable GPS receiver.

3.11.1 Mobile Data Computers

The MDC shall provide the user interface for the transmission of the Incident Reports to the Dispatch Center. The MDC shall keep an audit log file of all communications.

The MDCs shall be wirelessly connected to TOM. Security of the wireless connection shall be provided by requiring the user to log-in.

3.11.2 Voice communications

Road Supervisor Subsystem equipped vehicles shall utilize the TOM voice radio system and mobile radios for communications, with selective call. Transit supervisors shall also be able to call a bus directly using a portable radio.

3.12 TRAVELER INFORMATION SUBSYSTEM

TOM shall determine dynamic estimated time of arrival to the next stop for each bus and provide updates to the bus schedules based on the AVL information. This information shall be available for electronic display signs and monitors, web pages and traveler information systems and shall be compatible for future interfaces to the RIITS network and regional traveler information systems.

TOM shall also provide a means for TTS personnel to access dynamic bus location information and dynamic estimated time of arrival information via the TTS network or a TTS web page.

The time of arrival information shall be based on a predictive algorithm that utilizes the current AVL information for the approaching buses. The following time of arrival information shall be displayed: line number, and estimated time of arrival of the next bus in minutes. The time of arrival information shall be updated whenever updated AVL information is received for the approaching bus. Proposers shall provide details on how quickly the TOM shall reset the display signs and monitors when a bus departs from a stop. The long-term average accuracy of the predictive algorithm shall be such that the average error across all stops at all time is less than 20% of the headway. In the event AVL information for the approaching bus is not available, TOM shall either default to displaying

the static schedule or not displaying any information. The electronic signs and monitor shall also display the current time, canned general service messages, and text messages sent by a lead bus operator using a Dispatch Center workstation or a transit supervisor using the Road Supervisor subsystem.

The electronic display signs and monitors shall provide continuous, unattended, stable operation. The display signs and monitors shall provide diagnostic information to the dispatcher in the event of a failure. The Contractor shall provide tools to configure the signs and the monitor to display information for the applicable bus lines.

As an option, the Contractor shall perform all tasks necessary to install three electronic display signs and one monitor. The proposer shall provide option pricing for up to 10 additional electronic display signs.

IVR (Option)
The Contractor shall provide an IVR system that will provide real time time of arrival information for callers that enter in a stop ID number. When the IVR subsystem receives a telephone call from a caller, it shall greet the caller with a short introductory message with brief instructions on using the IVR system. The IVR subsystem shall then provide the caller with voice prompts to enter a bus stop ID using a touch tone phone. Upon receipt of the bus stop ID, the IVR subsystem shall first repeat the bus stop ID entered and state the street location of the bus stop. Next, the IVR subsystem shall provide dynamic time of arrival predictions for the next three buses for each route that is serving the bus stop location, including direction of travel and destination.

The time of arrival prediction announced by the IVR subsystem for a vehicle shall be updated within one second after the TOM server receives a location update from the vehicle. The predictions announced on the IVR shall be the same as the predictions provided on the website 99% of the time.

The Contractor shall perform all tasks to implement the IVR subsystem and its interface with the City's telephone system.

The Contractor shall provide IVR management tools for the recording of general service announcements. The management tools shall enable TTS staff to create, edit, or delete audio files for bus stop names and locations, public service announcements, menu items, and real time messages, and to schedule when the messages shall be displayed. The management tools shall enable TTS staff to add menu items, and to monitor and display call traffic and telephone line activities. The Contractor shall provide IVR management tools to edit, add, or delete bus stop information in TTS' bus stop database. The IVR management tools shall allow an administrator to define the maximum amount of time allowed for callers to respond before the system prompts them again for their response. The tools shall also allow an administrator to define a maximum number of repeat prompts to be given by the system before the call is terminated. TOM shall monitor both IVR hardware and software and send an alert to IT and TTS staff when the system malfunctions. The IVR subsystem shall

automatically recover from power failures. All other standard IVR features and functions provided by the Contractor to other clients shall be included.

3.13 BUS SIGNAL PRIORITY (OPTION)

TOM shall be "Bus Signal Priority ready" and be configured to add Bus Signal Priority as an option. The proposers shall provide a description of the modifications and costs required to the TOM to implement a BSP system that conforms to the Countywide LA Metro Signal Priority architecture. TOM shall monitor schedule adherence and shall trigger a request for priority at an intersection when it is more than a user-selectable threshold behind schedule. The BSP subsystem shall also be capable of operating in a Mode 2 Headway Based. In this mode, a central site calculates the headways between the vehicles and determines if signal priority should be granted. TOM shall recognize the difference between near-side and far-sidestops when requesting priority. TOM shall store onboard a record of requests for priority and download this information via the wireless LAN. The GIS database for priority request trigger points for each BSP intersection shall be uploaded to the vehicles via the wireless LAN and stored onboard. The signal priority request to the intersection equipment shall be made via the onboard spread spectrum radio.

TOM shall also be capable of interfacing to LA Metro's Rapid Bus System so that TTS buses can operate as a Rapid Bus. TOM shall supply the TTS static schedules to LADOT's ATSAC to allow the Rapid Bus System to determine if the TTS buses are running behind schedule and require signal priority.

The proposers shall provide examples of previously implemented BSP systems.

4 TOM SYSTEM HARDWARE REQUIREMENTS

4.1 CONSOLES

TOM shall be furnished with two dispatch consoles with computer, display, input, and associated audio equipment to serve the functions identified.

As an option, the Contractor shall provide console furniture. If furniture is provided, Contractor shall submit complete, scaled drawings of dispatch consoles at the Dispatch Center <CDRL>. Drawings shall show expected sight lines and range of movement for console operators. Samples of console surface finishes shall be submitted. The location of the consoles shall be identified during the pre-bid meeting.

4.1.1 Dimensions

If furniture is provided, the footprint dimensions of each console shall not exceed 88" x 37". The console depth shall be the minimum required to support the supplied equipment configuration.

4.1.2 Style

If furniture is provided, all consoles shall be neat in appearance, and shall be designed and constructed for the comfort, safety, and efficiency of the console operators.

a) The consoles shall be desk-style, with built-in areas for the various console devices, and curved or angled to permit convenient reach to devices from a seated dispatcher or supervisor.
b) The make, color, and appearance of all consoles shall be identical.
c) The consoles shall not restrict the dispatcher's ability to interact with bus operators at the window.

4.1.3 Computer

The computer shall use the most current commercial technologies for the processor, RAM and hard drive memory, video cards, audio cards, DVD RW, and CD-RW—subject to approval by TTS.

4.1.4 Displays

TOM consoles shall have either two or three display screens, as dictated by ease of operation. Displays shall be arranged so as to all be at the same height.

a) The visible diagonal of the screens shall be at least 22 inches.
b) The pixel resolution shall be at least 1280x1024
c) The pitch shall be .25 or less
d) The technology shall be LCD
e) The height and tilt of the displays shall be adjustable

4.1.5 Keyboard Tray

If furniture is provided, a pullout keyboard tray shall be furnished beneath the console desktops with vertical height adjustment. The keyboard tray shall include space for a pointing device (mouse or trackball.)

4.1.6 Input Devices

There shall be exactly one keyboard and exactly one cursor control mouse (optical) or trackball provided for the console.

a) The mouse or trackball shall operate across all displays
b) The keyboard inputs shall be directed to the current input area selected by cursor or software.

4.1.7 Console Audio Hardware

4.1.7.1 Audio Jacks

Audio jack receptacles for monitoring selected audio with headsets shall be located beneath the workstation desktop. When a headset is plugged in, the audio path to the select speaker shall be disconnected. Two headset interface jacks shall be furnished with each set of console equipment. The jacks shall include a volume-control adjustment with a minimum-volume stop and shall include a pre-amplifier for the headset microphone. When a headset is plugged in, the select audio at the console audio interface unit shall be routed to the headset.

4.1.7.2 Microphone

A noise-canceling, gooseneck microphone shall be integrated into the console.

4.1.7.3 Speakers

Select and unselect speakers shall be located on the work surface of the console. Select and unselect audio speakers shall have individual volume controls located on the enclosure. Mute capability shall be provided for the unselect speaker. The select volume control shall have a technician-removable minimum volume stop so that it cannot be adjusted to an inaudible level. Each select and unselect audio speaker shall be a 5-watt (min), 8-ohm speaker.

4.1.7.4 Headsets

The Contractor shall furnish Plantronics-style headsets the meet the following requirements:

- Headset coil cord shall measure 15 ft.
- Microphone shall be a noise canceling type compatible with the audio preamp.
- Ear set shall be a 300-ohm receiver with cushioned earpieces.
- Microphone and ear set shall be attached to a padded, adjustable leather headband.
- Coil cord plug shall match the audio jack receptacle type.
- Option for wireless headsets shall be provided.

Ten (10) headsets shall be furnished.

4.1.7.5 Foot switch (Option)

A push-to-talk (PTT) foot switch shall be furnished with each console equipment set. The foot switch shall be of rugged construction with nonskid feet. The foot switch shall be connected with a heavy-duty insulated cord. The foot switch shall be configured for operation in parallel with the console PTT.

4.1.7.6 Instant Recall Recorder (Option)

An instant recall recorder capability shall be furnished for each CAD console. The recorder shall be digital and shall be integrated with the console processor. The recorder's controls shall be available through the console graphical user interface and the console GUI shall emulate indications from the instant recall recorder. The instant recall recorder shall be configured to record the console audio and replay that audio upon demand through the unselect speaker, muting the unselect audio during playback.

4.1.8 Printers (Option)

A LAN connected printer that can be shared among the consoles in the Dispatch Center shall be provided.

a) Console users shall be able to direct printer output to a default printer, or to a specific printer on the TOM LAN.
b) The printer shall be a laser printer, with a minimum 600 dots per inch resolution and minimum 17 page per minute throughput, and use the most current technologies.

4.1.9 Lighting

If furniture is provided, task lighting shall be provided at each position on each console, controllable at the console.

4.1.10 End-to-End Requirements

The following requirements shall be met for transmit and receive channels, from microphone input to line-card output and from line-card input to console-speaker output:

- Frequency response: +1 to -3db, 300 to 3200 Hz
- Distortion: <=2.0%
- Hum and noise: >50 dB below audio
- Crosstalk: >60 dB below audio
- PTT response time: <=1 second
- Switching setup time: <=1 second from selection to execution

4.1.11 Construction

If furniture is provided, the following requirements apply.

4.1.11.1 Structure

Consoles shall be modular-style furniture. The console surface shall provide a convenient, contiguous writing surface. Consoles shall be height adjustable to accommodate 10^{th} percentile female to 90^{th} percentile male, and be ADA compliant.

4.1.11.2 Console Writing Surface

A writing surface, approximately 19 inches deep shall be provided on the top-of each console with adequate work surface space for three 9”x12” binders. The console writing surface shall be a flat surface with rounded edges and corners. The writing surface shall be finished with a nonmetallic material and shall be constructed to resist warping, chipping, and cracking. The console writing surface shall be finished in a neutral color approved by TTS.

4.1.11.3 Drawers and Storage Space

The consoles shall contain at least:

- two file drawers with minimum depth of 16 inches
- pencil drawer
- processor shelf.

4.1.11.4 Console Connections, Power, and Cabling

a) All wire and cable connections, power interfaces, and cabling shall be designed, constructed, routed, protracted, and located for operating and maintenance safety.
b) External power shall be supplied from a 120 VAC UPS power source, supplied by the Contractor.
c) Console power switches shall be accessible but shall be protected from inadvertent bumping or knocking.
d) Power outlet strips of adequate capacity to power all console electronics, plus 20% spare, shall be provided in each piece of console furniture.
e) Cabling for external power, and data and voice communications shall enter through the base of one bay of each console and shall be protected from chaffing. Jacks, plug connectors, connectorized terminal blocks and AC outlet strips for all connections external to the console shall be located in this area.
f) Cables and connectors shall be clearly labeled and shall utilize internal cable guides.
g) Cable connections to display monitor and input devices shall utilize plug connections and be located to allow for safe and quick replacement in the event of a failure.
h) Cables from console-top devices shall be routed through covered knockouts, or approved equal. Cables shall be dressed neatly in covered troughs.

4.2 COMPUTER SUBSYSTEM EQUIPMENT

TOM Computer Subsystem equipment shall be configured for high availability and operational flexibility, using the most current commercial technologies. It shall be designed to operate seven days per week, twenty-four hours per day.

4.2.1 Architecture

The TOM Computer Subsystem equipment shall be configured as a distributed system of servers, switches, hubs, routers, printer, dispatcher, management and system administrator consoles, gateway equipment, configured together as a redundant local area network (LAN).

a) Network equipment shall be provided with two network interface cards, allowing each piece of network equipment and the overall TOM to continue operating given the failure of one of the two redundant LANs.
b) The computer equipment hardware and software shall function and be configured in a manner such that while TOM continues to operate and be "fully available", TOM shall provide for reconfiguration, replacement, resumption of operation, and automatic re-incorporation into the working TOM configuration of failed components such as console and workstation equipment, printers, LAN equipment, and database servers.

Servers and related equipment shall be located at the TTS facility and connected via LAN to the consoles.

4.2.2 Characteristics

Console and LAN computers and peripheral devices shall be commercially available, commonly used, off-the-shelf equipment and utilize a current Windows operating system. Servers shall be RAID 5 with dual processors.

Servers shall have the hardware and software necessary to allow archiving and restoring data to an external digital medium—such as a DVD. Archiving shall be configurable to operate automatically on a periodic basis. TOM shall automatically notify the appropriate TTS and City IT personnel if there are manual needs, such as loading new media into a drive.

4.2.3 Uninterruptible Power Supply

The Contractor shall implement an Uninterruptible Power Supply in the server room to handle the TOM load for a minimum of eight hours. The IT department shall be alerted if there is a power outage. The Contractor shall submit necessary power and environmental load data to TTS <CDRL>.

4.2.4 Delivery

TTS shall be notified in writing at least two weeks in advance of each proposed delivery date of equipment.

Equipment shall be delivered to Torrance Transit Systems in heavy-duty boxes. The exterior of each box shall be labeled, including manufacturer, equipment type, serial number, and date.

Equipment shall be delivered to an inside location designated by Torrance Transit Systems. Each shipment shall be accompanied by an inventory list showing the quantities, serial numbers, and brief description of all items.

4.2.5 Computer Subsystem Equipment and Dispatch Center Installation

The Contractor shall install all Computer Subsystem equipment and Dispatch Center equipment, dispatch consoles, and monitoring consoles furnished as part of TOM. Contractor shall supply and install all cabling and other connections to existing utilities and TTS computer equipment. Contractor shall supply and install any required racking that is not presently available. Contractor shall be aware of all applicable local and State of California safety regulations, procedures and requirements and shall conform in all aspects of installation.

The Computer Subsystem Equipment shall be installed at a location in the TTS facility as designated by TTS.

Contractor shall provide a record of all Computer Subsystem and Dispatch Center installations including photographs of the installations.

4.2.5.1 Design Submittals

The Contractor shall submit detailed, scaled plans showing installation of all equipment and routing of all cables <CDRL>.

4.2.5.2 Removal of Equipment

Existing communications, computer equipment, and cables shall be removed by TTS after it has been officially retired. Any re-arrangement of existing equipment to accommodate TOM shall be performed by the Contractor, with TTS approval and supervision.

4.3 VOICE RADIO SYSTEM INTERFACE

The dispatch console shall interface with the existing base station via wireline control. Two voice control stations shall be provided for each dispatch console as a back up to the wireline connection. In voice fallback mode, one of the control stations shall operate on the primary bus dispatch group and the second control station shall act as a scanner, monitoring all of the other groups (Supervisor, Maintenance, Special Event, etc.).

Subsequent to the installation completion of the TOM to the voice radio system interface, correct operation of the interface shall be verified through self-diagnostics and actual call set-up.

4.4 WIRELESS DATA COMMUNICATION SUBSYSTEM

If a data radio subsystem is implemented, the following requirements in this section shall apply.

The data controller for the data radio subsystem shall interface with the data base station via T1 to the site(s). If the current site is selected by the Contractor, the City T1 shall be be used. The current channel bank is a Newbridge Mainstreet equipped with 12 each 2 slot 4 wire E&M cards. If a different card is necessary for the data controller to base station connection, the Contractor shall furnish the necessary cards and replace one of the existing cards in each channel bank with the new ones.

4.4.1 Base Station

The following specifications are to serve as a guide for minimum acceptable standards for an analog base station per TIA/EIA 603.

4.4.1.1 Transmit Section

- Frequency Range: 851-870 MHz
- Rated Power Output: 60 Watts, Minimum
- Output Impedance: 50 ohms
- Conducted Spurious and Harmonic Emissions: 80 dB
- Intermodulation Attenuation: 50 dB
- Frequency Stability: 0.0001 %
- Modulation Deviation: 0 to ± 5 kHz, ± 4 kHz for 866-870 MHz
- FM Hum and Noise: 50 dB
- Audio Distortion, analog: < 2% 1000Hz @ 60% RSD
- Channel Spacing: 12.5 & 25 kHz selectable
- Duty Cycle: Continuous (100%)

4.4.1.2 Receive Section

- Frequency Range: 806-825 MHz
- Input Impedance: 50 ohms
- Channel Spacing: 25 kHz
- Bandwidth: 12.5 & 25 kHz selectable
- Sensitivity: -116 dBm, 12 dB SINAD
- Selectivity: -70 dBm @ 12.5 kHz, -80 dBm @ 25kHz
- Adjacent Channel Rejection: 70 dB @ 12.5 kHz, 80 dB @ 25 kHz
- Frequency Stability: ± .0001 PPM
- Intermodulation Rejection: -85 dB
- Spurious and Image Rejection: -100 dB
- Audio Distortion: < 3% 1000 Hz @ 60% RSD

4.4.1.3 Monitoring

The base station shall be equipped for self-monitoring and shall report alarms and diagnostic information via a site monitor to the Dispatch Center. Battery Revert (loss of AC power), Forward Power Alarm (<50% power out), Power Amplifier Failure, High Reflected Power (>25%), and Receiver Alarm shall be monitored and displayed locally, as well as made available for display at the Dispatch Center.

4.4.2 Data Radio Control

The mobile data communications protocol shall be optimized for the short message length typical of this type of system. Long modem training times and extensive pre-ambles shall be avoided. The protocol shall provide for efficient reporting of changes of state in real time and shall also provide for regular status checks of all mobile units to verify that data

communications is functioning properly. Specific system response times for individual messages and status checks shall be as defined in Section 3 of this Specification.

The protocol used shall be fully documented. All necessary messages to support the specified mobile functions shall be defined in the data protocol. Complete details of the data protocol shall be submitted to TTS for information purposes <CDRL>.

Allocation of data channel utilization shall be dynamic so as to maximize throughput under the actual current conditions. Allocation of data channel utilization shall provide sufficient message slots for real-time messages to support all operator messages during pullout of the maximum design fleet, while continuing to support specified response times for all other functions.

4.4.2.1 Periodic Reporting

TOM shall communicate with each active (powered-up) vehicle at least once every 15 seconds. TOM shall have the ability to enable fast polling for selected vehicles. TOM shall use an efficient means of controlling this periodic reporting such as group or synchronized polling. Traditional single vehicle poll-respond cycles are not efficient and shall not be acceptable. The time period for reporting shall be adjustable by the system administrator. TOM shall support reporting from selected vehicles on fifteen second, thirty second, and forty-five second intervals when an SAS is active and when a PRTT is queued.

4.4.2.2 Acknowledge

The successful transmission of all data messages between the Onboard subsystem and the TOM fixed data radio subsystem shall be acknowledged, independent of the receipt of the message at the target application. If an Acknowledge message is not received within the appropriate time period, a re-try algorithm shall be utilized.

4.4.2.3 Error Detection

The maximum bit error rate (prior to error detection and correction) across the data radio channel shall be less than $1x10^{-4}$ with a 12 dB SINAD radio signal. The protocol shall utilize an error detection scheme that shall reduce the probability of an incorrect message being accepted to less than $1x10^{-6}$.

4.4.2.4 Data Rate

The minimum bit rate shall be 19,200 bits per second with a 25 kHz channel bandwidth. Effective throughput shall be at least 50% of these rates.

4.4.2.5 Data Radio Status

Base station alarms, base station output power, transmit combiner power and VSWR, and site alarms shall be monitored and made available at the TTS facility via the master console. Site alarms shall include cabinet intrusion, AC power and standby power status.

4.4.3 Power Requirements

The primary power source for all system equipment shall be 120 VAC commercial power with backup generator power provided by the City at the radio site. Each base station shall be equipped with a 24 V standby battery with sufficient Amp/Hour rating to operate the station for four (4) hours to prevent loss of system functionality during the automatic transfer from primary to back-up power. The base station power supply shall provide equalize and float charge capability for the battery. The batteries shall be a standard 12 Volt, gell cell sealed type readily available from local sources. Two batteries shall be used in series for each station. The battery for each station shall be housed in the city provided battery cabinet. All system equipment shall be capable of utilizing 24 VDC and 120V AC power.

The following information shall be submitted <CDRL>:

- A power load calculation shall be provided by the Contractor to establish if any expansion of the battery and charging systems are necessary due to the addition of the data base station equipment.
- A description of how a backup power scheme is implemented so that the system is resilient to power source failures.
- The expected time that the battery will support operation of the base station @ 3 dB reduction in output power and at full power.
- Service life of battery before replacement is necessary. Battery warranty.
- Power and HVAC loads for each piece of equipment at the site.
- A list of the required primary power circuits with recommended circuit breaker capacity for the individual loads at the site.

4.4.4 Site Environmental

All equipment shall support Bellcore's Network Equipment Building System (NEBS) criteria. As described in Bellcore's SR-3580, all equipment shall support the Level 3 criteria described in Section 3.3 of SR-3580 and the referenced requirements from Bellcore's GR-63 and GR-1089. These requirements include the following:

- Operational Thermal, Short Term Conditions as described in GR-63, Criteria 72,73
- Storage Environments, Transportation and Handling as described in GR-63, Criteria 69-71, 107-109, 124.
- Earthquake Zone 4 as described in GR-63, Criteria 110-112, 114, 115, 117, 119.
- Airborne Contaminants Outdoor Levels as described in GR-63, Criteria 126, 127.
- ESD Installation and Repair as described in GR-1089, Criteria 4.
- EMI Emissions as described in GR-1089, Criteria 9
- EMI Immunity as described in GR-1089, Criteria 16, 18
- Steady State Power Induction Conditional Requirements as described in GR-1089, Criteria 43, 45, 50, 52.

4.4.5 Installation

4.4.5.1 Factory Installation

4.4.5.1.1 Equipment Wiring

Each individual rack or cabinet shall be completely factory pre-wired and tested. Connections between equipment within a single rack or cabinet shall be made with wire-wraps, terminal posts, or similar semi-permanent connections. Connections of multi-pair cables external to the rack or cabinet shall be made with plug-type connectors to the extent possible. RF connections shall be type N. Wiring and cables shall be securely bundled and tie-wrapped. All connectors and cables shall be clearly labeled.

4.4.5.1.2 Equipment Mounting

Equipment shall be mounted within equipment racks and cabinets on EIA standard 19" or 23" rails. Cabinets shall be suitable for Zone 4 seismic loads and shall include bracing for mounting.

4.4.5.2 Field Installation

4.4.5.2.1 Site Coordination and Preparation

The Contractor shall perform all required coordination with the owners of the base station site(s) for access to the site and for any site physical modifications necessary. The Contractor shall obtain all necessary licenses and permits, and bear all site coordination and preparation costs.

4.4.5.2.2 Utilities Coordination

The Contractor shall perform all required coordination for telephone and electric utility service at the base station site. All utility company charges in connection with new utilities will be paid for by TTS.

4.4.5.2.3 Cabinet Installation

Cabinets and racks shall be bolted to the floor where allowed by the site owner. Bracing to withstand earthquakes shall be provided as appropriate to the site infrastructure. Overhead cable trays shall be bolted to the racks and cabinets or to the ceiling where allowed by the site owner. Each equipment cabinet shall be grounded to the site ground bus.

4.4.5.2.4 Antenna Mounting

Antennas shall be mounted in accordance with the manufacturer recommendations to achieve stability with winds of at least 110 miles per hour. Antennas shall be grounded to the building structural steel or tower structure, as per the manufacturer recommendations.

4.4.5.2.5 Transmission Line

Transmission lines shall be installed carefully to avoid kinks and so as not to exceed the minimum bend radius. Transmission lines shall be secured with tie-wraps or clamps every ten feet in horizontal runs. Transmission lines shall be secured every four feet with clamps in vertical runs. Transmission lines shall be grounded exterior to the equipment shelter, at a vertical to horizontal transition.

4.4.5.2.6 Equipment Removal

All equipment that may be retired shall be removed by the Contractor and delivered to a TTS designated location. Packing shall be utilized to avoid damage during shipment.

4.4.6 Functional Testing

4.4.6.1 Factory Tests

All equipment for the base station site shall be interconnected and tested as a unit after all factory wiring is completed. Testing shall be in accordance with the approved procedures. Minimum testing requirements shall be as follows:

4.4.6.1.1 Base Station Parameters

The operational parameters of the transmit and the receive sections of the base station shall be verified.

4.4.6.1.2 Failure Testing

Testing shall include forced failures to verify monitoring capabilities and correct fallback modes.

4.4.6.2 Installed Tests

Subsequent to completing installation at each site, equipment shall be inspected and functionally checked in accordance with the approved procedure. Equipment shall be tagged with the test and in-service dates. Minimum requirements for this testing shall include the following:

4.4.6.2.1 Base Station:

- Output Frequency
- Output Power
- Transmitter modulation
- Receiver Sensitivity

4.4.6.2.2 Antenna System:

- VSWR on each antenna line, transmit and receive

- Transmitter combiner losses per channel, if applicable
- Receive multi-coupler gain per channel, if applicable

4.4.6.2.3 Site Controller:

- Failure indications
- Fallback modes operational
- Channel request and channel grants operational

4.4.6.2.4 Interface to the Dispatch Center

- Alarms report
- Calls report
- GPS sync operational
- Phasing Delay
- Status tones frequency and level

4.4.6.2.5 Failure Testing

Testing shall include forced failures to verify monitoring capabilities and correct fallback modes.

4.5 ANTENNA NETWORK

If a data radio subsystem is implemented, the following requirements in this section shall apply.

The Contractor shall provide one antenna to be used for both transmit and receive for the data radio system.

4.5.1 Coaxial Cable

Coaxial cable diameter and loss properties shall be consistent with the loss budgets to achieve TOM coverage requirements. Coaxial cable shall have a solid, corrugated outer conductor and foam dielectric.

4.5.1.1.1 Superflexible Coaxial Cables

Superflexible coaxial cable of ¼" minimum diameter shall be used for short jumper cables. It shall have the following characteristics:

- Jacket material shall be fire retardant rated for intended application.
- Loss shall be less than 3.93 dB per 100 feet at 900 MHz.
- Relative propagation velocity shall be 84%.
- Minimum bend radius shall be 1".

4.5.1.1.2 Standard Coaxial Cables

Standard coaxial cable of 7/8" minimum diameter shall be utilized for antenna cabling. It shall meet or exceed the following characteristics:

- Jacket material shall be polyethylene except where fire retardant is required, rated for intended application.
- Loss shall be less than 0.83 dB per 100 feet at 900 MHz.
- Relative propagation velocity shall be 89%.
- Minimum bend radius shall be 10".

4.5.2 Antenna

Typical antenna performance for applicable types is specified below. The Contractor shall provide the antenna type to be utilized to TTS for approval, subject to licensing and mounting restrictions, to achieve the required coverage <CDRL>.

4.5.2.1.1 Omni-directional Antennas

Antenna shall be 7.5 dB gain omni-directional type, constructed of copper radiating elements enclosed in a weatherproof fiberglass housing.

- Frequency Range: 806-870 MHz
- Bandwidth: 64 MHz
- Nominal Impedance: 50 ohms
- Maximum Power: 400W
- Lightning Protection: Direct Ground
- Rated Wind Velocity: 100 MPH
- Termination: Type N

4.5.2.1.2 Panel Directional Antennas

Antenna shall be constructed of copper radiating elements enclosed in a weather resistant plastic radome.

- Frequency Range: 806-870 MHz
- Bandwidth: 64 MHz
- Gain: 9 dB minimum
- Horizontal beamwidth, minimum: 100 Degrees
- Downtilt: 0-10 Degrees
- Nominal Impedance: 50 ohms
- Maximum Power: 250 W
- Front to Back Ratio: 25 dB minimum
- Lightning Protection: Direct Ground
- Rated Wind Velocity: 100 MPH
- Termination: N - Female

4.5.2.1.3 Corner Reflector Antennas

Antennas shall be constructed of high strength aluminum alloys.

- Frequency Range: 806-870 MHz
- Bandwidth: 64 MHz
- Gain: 10 dB
- Horizontal Beamwidth: 60 Degrees
- Downtilt: 0-10 Degrees
- Nominal Impedance: 50 ohms
- Maximum Power: 300 W
- Front to Back Ratio: 25 dB minimum
- Lightning Protection: Direct Ground
- Rated Wind Velocity: 125 MPH
- Termination: N-Male

4.6 ONBOARD SUBSYSTEM

The equipment specifications are meant as a minimum performance standard of equipment generally available for the transit environment.

4.6.1 Onboard TOM Processor

4.6.1.1 TOM Processor

The Onboard TOM Processor shall be:

- Based upon a commonly-used, widely-available microprocessor of current technology, suitable for mobile applications.
- Of sufficient capacity to support the full set of functions of TOM plus 50% additional capacity for future use in any combination of operation without degrading apparent operation of any functions. Calculations or simulations shall be provided to support excess capacity.
- Field-expandable to at least four times the memory capacity required. Memory expansion shall be accomplished by addition of cards or expanding modules capacity.
- Of sufficient durability to withstand and continue normal operation in the rigorous environment of the vehicle, including dust, water, and severe vibration.
- Housed in an enclosure that is separate from the Mobile Data Terminal and installed in an equipment compartment.

4.6.1.2 Software

Contractor shall furnish the complete software, instructions, test procedures, tools, and data to re-load the MDT. Contractor shall furnish a mechanism for loading software updates into all vehicles in a managed process within a three- hour period, via the wireless LAN.

TOM software for the Onboard Processor shall be self-diagnostic and shall include self-restarting of processes. Stability of this software shall be enforced through rigorous testing at all stages of development, as per IEEE software quality assurance requirements.

4.6.1.3 Communications

The Onboard TOM Processor shall provide for multi-protocol communications with all in-vehicle TOM devices, and external devices. The Onboard TOM Processor shall handle each request for information on each physical data line, address the functional component that has the information stored, and provide the information to the requesting functional component in the appropriate format. Sufficient ports shall be provided for each interface so as not to cause conflicts in port access.

The Onboard TOM Processor shall store all data required for the onboard subsystem that is not stored in any of the other components. The route and schedule database shall be stored in the Onboard TOM Processor. If the BSP option is exercised, the Onboard TOM Processor shall store the database for the BSP subsystem.

The Onboard TOM Processor shall maintain and provide precise timing to all in-vehicle components, utilizing GPS time from the AVL subsystem as the synchronization reference.

The Onboard TOM Processor shall collect data from other elements, determine status of the bus and shall control communication of this information via the data radio or cellular data modem.

The Onboard TOM Processor shall respond to queries for information from the Dispatch Center via the data radio or cellular data modem and the wireless LAN.

4.6.1.4 Modem

If a data radio system is implemented, the modem shall communicate via the data radio channel, utilizing the protocol as defined in Section 4.4 of this Specification. The modem may be implemented as part of the Onboard TOM Processor or as a physically separate unit. Torrance Transit Systems will also consider an integrated modem and data radio.

If a data radio system is not implemented, the modem shall communicate via a cellular data network.

4.6.2 Mobile Data Terminal (MDT)

The Onboard TOM subsystem shall include a Mobile Data Terminal (MDT) that shall act as the interface between the bus operator and TOM. The MDT shall support all of the radio and messaging control functions outlined in Section 3.8.

Proposals shall provide a complete description of the proposed MDT and describe the MDT mounting details for each type of TTS vehicle, including fixed route buses and support vehicles.

The Contractor shall provide a full specification for the MDT interface to other TOM elements <CDRL>.

4.6.2.1 Keypad

The MDT shall provide at least 16 numeric/function key buttons or softkey equivalents for operator entry of numeric data, commands and control functions.

The MDT application shall include recognition of operator depressions of soft keys representing the following functions, at a minimum:

- Menu driven capability for Operator logon and confirmation of Route/Run identifier and Operator
- Badge Number and subsequent transmission to TOM;
- Request to Talk Functions of the priorities available in TOM (RTT, PRTT and additional categories if needed) and Cancel;
- Use Vehicle PA system;
- Volume up, down/midpoint control of all audio volume (level) settings for PA, headset (if used), and the bus operator's speaker and adjustable lighting functions (intensity, contrast, other if available);
- Received data message notification, selection and scrolling;
- Display of System Time of day;
- Operator access to canned data message reporting to Dispatch Center for:
  - Urgent: Non-emergency police required, no relief driver, fare disputes and other time sensitive messages,
  - Priority: Mechanical difficulty digital reports and other digital messages to/from vehicle and higher priority voice requests, accident, breakdown
  - Routine: Layover and other normal or routine message requests
  - A partial list of additional messages that shall be provided is listed in Appendix C.
- Numeric identification entry (for example, log-on/log-off);
- Scrolling up and down through messages from the Dispatch Center to the operator;
- Response/acknowledge of messages to the operator;
- Out of service;
- Lift used.

4.6.2.2 Physical Configuration

4.6.2.2.1 Physical Structure and Materials

The TOM MDT shall be made of ruggedly constructed, and suitably reinforced for rigidity. Physical details of the MDT and mounting structure shall be submitted to TTS to installation for approval <CDRL>.

4.6.2.2.2 Mounting

MDT mounting shall be proposed by the Contractor and submitted for approval by TTS <CDRL>. It is preferred that the MDT shall be mounted via a flexible arm arrangement, and into a lockable position. This shall allow the operator to move the unit within a restricted range of movement, allowing comfortable observation of displays and operation of the controls from a seated position. Any flexible arm shall be designed to prevent autonomous swaying, movement or vibration throughout the life of the TOM equipment, and as well as the TOM MDT.

Mounting of the MDT shall allow for removal and replacement of the entire unit (including mounting arm) within 10 minutes.

As an option, Contractor shall install the MDT on a rail-type mount such that the location of the MDT and handset can be adjusted to be closer or further away from the operator. This mount was developed by the Santa Monica Big Blue Bus. It is also being used at Culver CityBus. Torrance Transit Systems will provide the rail hardware. Contractor shall provide a bracket to attach the MDT to the rail and install the rail. Contractor shall ensure the cables for the handset and MDT are long enough to allow the handset and MDT to be set at any location on the rail.

4.6.2.2.3 Electrical Wiring

All vehicle wiring shall be to the mating connectors on the stationary outer skin, or cover, of the MDT assembly. Cable “stubouts” are unacceptable.

4.6.3 Handset

Contractor shall use the existing handset or provide and install one. If provided, the noise-canceling handset shall be a rugged telephone-style unit with push-to-talk key switch. The handset cord shall be armored. The handset cradle shall retain the handset such that it shall not dislodge during normal transit bus operations. The handset hookswitch shall cause audio to be lifted from the speaker and shall cause receive audio to be connected to the handset.

4.6.4 Speaker

The Contractor shall use the existing speaker or provide and install one. If provided, the speaker shall be enclosed in a rugged enclosure with the speaker cone protected by a baffle, or within the MDT housing. Speaker electrical characteristics shall be consistent with the mobile radio receiver audio output specifications. There shall be provisions for an externally mounted speaker, where the supplied speaker is internal to the MDT.

4.6.5 Covert Microphone

A microphone, which can be remotely activated by the Dispatch Center, shall be incorporated into the MDT or within a rugged covert enclosure. The microphone electrical characteristics shall be consistent with the mobile radio handset microphone specifications. If the supplied covert microphone is internal to the MDT, there shall be provision for additional, externally mounted, covert microphones. The covert microphone shall be activated whenever the SAS is activated. Activation of the covert microphone shall be indicated by a subtle change in the display, such as not blinking the colon in the time display.

4.6.6 Silent Alarm Switch

Contractor shall use an existing SAS pushbutton or provide and install an SAS pushbutton in a covert location accessible to the driver, but positioned away from other controls to avoid accidental activation. The pushbutton shall not be mounted on the MDT. The pushbutton shall be shrouded to avoid accidental activation and shall be at least ½" in diameter. The pushbutton shall be electrically supervised by TOM such that disconnection or failure of the pushbutton shall be detected.

4.6.7 Voice Mobile Radio Interface

TOM shall interface with the existing mobile voice radio. The operator interface for the radio shall be the MDT as described in Section 4.5.2.

4.6.8 Wireless Data Modem

If the Contractor does not implement a data radio system, the following requirements in this section shall apply.

The Contractor shall provide and install a mobile device that connects to a cellular data service established by the Contractor. The cellular data device shall be an integrated package, within a rugged enclosure designed to withstand the transit industry environment, when installed within an equipment box. The mobile wireless data device may include an integrated modem or shall utilize the modem as per Section 4.5.1.4.

The cellular wireless data device shall be FCC type accepted for transmission of digital signals.

Proposers shall provide make, model, and specifications for the cellular data device to be provided. Proposers shall include a description of any proposed encryption, including type of encryption used, key size and if the encryption is always active.

Option: An external antenna shall be necessary if the coverage using an internal antenna provides marginal coverage. The antenna frequency range shall be adequate to cover the entire band in which the data service is operating. The antenna shall be heavy-duty, unity gain or 3 dB gain, enclosed in an impact-resistant resin plastic radome. The antenna shall not require a metal ground plane for rated performance. The antenna shall mount with a weather-tight gasket. Alternate methods may be proposed, such as a GPS or spread spectrum antenna integrated into the antenna housing with or without a combined transmission line.

4.6.9 Data Radio

If a data radio system is implemented, the following requirements in this section shall apply.

The transmit and receive sections of the mobile data radio shall be an integrated package, within a rugged enclosure designed to withstand the transit industry environment, when installed within the radio equipment box. The unit shall not be installed within the driver's compartment. The data mobile radio may include an integrated modem or shall utilize the modem as per Section 4.5.1.4.

The mobile radios shall be Frequency Modulation (FM) type capable of operating on a minimum of 16 pre-programmed channels. All units shall be solid state and frequency synthesized. Radios shall be field programmable.

Requirements for the mobile data radios are dependent on the frequency of the data channel(s). Data radios are required to operate on both 12.5 kHz and 25 kHz bandwidth channels.

4.6.9.1 Transmit Section

- Frequency Range: 806-869 MHz
- RF Power Output: 15-35 watts (variable)
- Frequency Stability: ± 1.5 PPM (-30°C to +60°C)
- Modulation Deviation: ±5 kHz or ±2.5 kHz
- Spurious and Harmonic Emissions: -70dB
- FM Hum and Noise: -40 dB (Wideband), -40 dB (Narrowband)
- Audio Distortion: <3% at 1KHz
- Audio Response: +1, -3 dB of 6dB/octave Pre-emphasis
- Antenna Impedance: 50 ohms
- Operating Voltage (for full performance): +11 to +14.5 VDC, fused
- Channel Spacing: 12.5 kHz

4.6.9.2 Receive Section

- Frequency Range: 851-869 MHz
- Frequency Stability: ±1.5 PPM (-30°C to +60°C)
- Modulation Acceptance: ±2.5 kHz
- Channel Spacing: 25 kHz
- Minimum Sensitivity: 0.35 uV (EIA 12 dB SINAD)
- Spurious and Image Rejection: -75 dB
- Intermodulation: -75 dB
- Selectivity: -75 dB
- Audio Distortion: < 3%
- Antenna Impedance: 50 ohms

4.6.9.3 Antenna

Antennas shall be heavy-duty, unity gain or 3 dB gain, enclosed in an impact-resistant resin plastic radome. Antenna shall not require a metal ground plane for rated performance. Antenna shall mount with a weather-tight gasket. Alternate methods may be proposed, such as a GPS or spread spectrum antenna integrated into the antenna housing with or without a combined transmission line.

4.6.10 Spread Spectrum Radio

4.6.10.1 Type and Performance

The Onboard subsystem spread spectrum radio shall be configured for high volume, off-line bi-directional transfer of data, including route and schedule databases, passenger counts, and vehicle health data. The mobile spread spectrum radios shall operate with the Yard Access Point radios, as specified in Section 4.6 of this Specification.

The wireless LAN Equipment shall conform to the Wireless Ethernet Compatibility Alliance certification standards for interoperability among IEEE 802.11g products from multiple manufacturers.

- Frequency: 2.4-2.4835 GHz
- Minimum Range: 1200 ft (bus yard environment)
- IEEE 802.11g Wireless Local Area Network
- Data Rate: 1Mbps to 54 Mbps
- Operating Temperature: -10 to +60 C
- Interface: RS-232 or RS-485
- Connector: DB-9 or approved equivalent
- Power: 12 VDC
- FCC Part 15 Compliant

4.6.10.2 Physical Configuration

The spread spectrum transceiver shall be of rugged construction, suitable for use in a bus transit environment installed within the radio equipment box.

4.6.11 Automatic Vehicle Location Subsystem

4.6.11.1 GPS Receiver

The GPS receiver shall be the time source for the TOM in-vehicle time used for mobile data terminal display, for the AVA display, and to time-tag all recorded events. The GPS receiver shall be designed for use with an AVL application, and shall be of rugged design suitable for a transit environment.

Input messages shall include correction data sent from the GPS differential station over the mobile data channel to the GPS receivers in each vehicle.

The general receiver characteristics shall be as follows: LI frequency, C/A code, 12 channel (minimum), continuous tracking. The output data messages shall include the following: latitude, longitude, velocity, time, and direction of travel. Output message data rate shall be selectable, 300 - 9600 baud. Output messages format shall be a documented, non-proprietary protocol.

If the GPS receiver does not have the WAAS almanac preloaded, the Contractor shall upload the WAAS almanac into the GPS receiver. The Contractor shall configure the GPS receiver to receive the WAAS data.

Updates occur once per second (minimum) and are user selectable.

- System Accuracy (S/A on): 100 meters maximum
- System Accuracy (S/A off): 25 meters maximum
- System Accuracy (WAAS): 7.6 meters maximum
- Velocity Accuracy (S/A off): 0.1 meter/s
- Time (S/A off): 1.5 microseconds
- Cold Start Acquisition Time: 2-4 minutes
- Warm Start Acquisition Time: <30 seconds

- Reacquisition Time: 2 seconds
- Operating Temperature: -30C to +85C
- Operating Voltage: 2W, 9-28 VDC
- Battery Voltage: 0.5mW, 3.5-32 VDC

4.6.11.1.1 Physical Configuration

The GPS receiver housing shall be constructed of anodized sheet metal, suitable for use in a transit environment. The receiver shall meet vibration requirements as per MIL Standard 810E. GPS receiver may be included as part of one of the other onboard equipment units rather than as a standalone device.

4.6.11.1.2 Antenna

The GPS receiver antenna shall be a patch type with low noise amplifier, enclosed in a low profile, hermetically sealed weatherproof radome enclosure. The antenna unit shall be a polycarbonate dome over a die-cast metal plate. The antenna enclosure shall be equipped with screw type mounting facilities. Alternate methods may be proposed, such as a GPS antenna integrated into the antenna housing data radio antenna with or without a combined transmission line.

- Center Frequency: 1575.42 MHz
- Polarization: RHCP
- Gain: 30dB
- Noise Figure: 1.5dB
- Axial Ratio: 3dB
- Bandwidth: 2MHz
- Attenuation: 20dB @ Fo +/- 50MHz
- Impedance: 50 ohms
- Output VSWR: 1.5
- Supply Voltage: 5V +/- 0.5VDC
- Current Consumption: 28mA
- Operating Temperature: -30C - +85C
- Storage Temperature: -40C - +90C
- Humidity: 95%, non-condensing
- Connector: TNC male or approved equivalent to mate with GPS receiver

4.6.12 APC (Option)

The Contractor shall install an APC subsystem in every TTS bus.

4.6.12.1 Sensors

Sensors shall be mounted in the optimal locations, subject to TTS approval, to detect passenger boardings and alightings at each doorway but shall not be mounted on the floor or steps.

4.6.13 AVA (Option)

4.6.13.1 Processor

The AVA processor shall interface with other Onboard TOM components for work assignment, vehicle location, status, and for database updates and downloads. The AVA processor may be implemented as part of the Onboard TOM Processor. The AVA processor shall utilize a current, commercially available operating system. Hard drive storage capacity shall be large enough to store two AVA databases plus an additional 25% to allow for future growth. The processor shall utilize commercially available components.

4.6.13.2 LED Signs

Two variable message signs shall be provided onboard each bus, controlled by the AVA processor through a serial interface. These units shall utilize a matrix of amber LEDs to display the text message equivalent of the stop announcements. The signs shall be mounted above and behind the driver and at the rear of the bus. The Contractor shall submit the mounting details for the signs for each series of bus showing hardware used, exact location of signs and expected sight angles for TTS review <CDRL>.

A single row of text shall be displayed on each sign. The text size and clarity shall be sufficient for announcements on at least one of the signs to be readable by a person with normal vision seated or standing anywhere within the bus and comply with ADA requirements.

Brightness of the signs shall be such that they are visible with normal ambient lighting conditions onboard the bus. Brightness of each discrete LED shall be at least 80 milli-candela at 35 degrees off-axis.

Vandal-resistant enclosures shall be utilized. The faceplate lens shall be scratch resistant. Cable connections to the sign enclosure shall be concealed behind the sign. Power for the signs shall be from the TOM equipment compartment.

4.6.13.3 Interface to Existing Headsigns

Headsigns shall be controlled by the Onboard Processor such that the headsign automatically displays the operator's work assignment, general service message, or out-of-service status. Torrance Transit Systems will upgrade its older headsigns such that all of the headsigns will be capable of electronic control. This includes any side-mounted destination signs. A

tentative list of sign types installed on Torrance Transit Systems' buses is provided in Appendix D.

TOM shall provide the data in the format necessary to control the headsign and shall not interfere with the function of the destination equipment. As multiple headsign models exist, Contractor shall provide separate software drivers for each type of headsign. When Onboard TOM equipment such as the Onboard processor is changed out, the correct headsign drivers shall be activated or loaded for the headsigns on the bus. Prompts shall be provided at the user interface for selection of the correct headsign type.

4.6.13.4 Interface to Existing PA Equipment

Audio announcements shall be made using the existing Public Address (PA) equipment onboard each bus. The Onboard TOM Equipment shall be interfaced to control interior and exterior announcements to the correct speakers. The TOM Equipment shall allow operator independent control of exterior and interior announcement volume within a specified range around the volume level set by ambient noise monitoring. Operators shall be able to adjust the volume of interior speakers between upper and lower limits, where the lower limit is constrained to a minimally acceptable audible level. The Contractor shall install PA equipment, if functional PA equipment is not available on the bus.

4.6.14 Interface to Video Surveillance Subsystem (Option)

TOM shall command the video subsystem to tag the video data and record at a rate of at least six frames per second for each video camera when an SAS is activated, or tagging is selected by the operator or remotely requested from the Dispatch Center.

The video recording unit clock shall be periodically synchronized, using the onboard TOM time, derived from GPS such that the time drift of the recorder clock, compared to GPS time shall be less than two seconds.

As an option, TOM shall transfer video data to the Dispatch Center via the wireless LAN subsystem.

4.6.15 Vehicle Health Monitoring (Option)

4.6.15.1 General Description

The Vehicle Health Monitoring (VHM) subsystem shall monitor the functionality, performance, and operation of onboard equipment that is equipped with a programmable

dispatcher for operator-controlled functions and indications. The VHM subsystem shall be capable of collecting, storing and transmitting health and diagnostic data from the equipment via physical connections, the data radio and wireless downloads.

4.6.15.2 Equipment Monitored

The VHM subsystem shall be designed to be flexible such that it can function with any mobile equipment that is equipped with a programmable controller and a SAE J1587/J1708 or SAE J1939 communications link. The VHM subsystem shall be capable of functioning with all existing mobile equipment and any new equipment that Torrance Transit Systems may acquire, provided that the equipment meets the above criteria. At a minimum, the VHM subsystem shall interface with and monitor the following pieces of equipment:

- All Onboard TOM subsystems
- Electronically-controlled diesel and natural gas engines in the buses listed in Appendix D.
- Electronically-controlled Allison transmissions in the buses.
- Multiplex systems in Torrance Transit Systems buses and selected equipment--doors, wheelchair lifts, lights, etc.--that are interfaced with the multiplex system.

4.6.15.3 Data Collected

The VHM subsystem shall be capable of accessing, collecting and storing any data available from the programmable controller through the communications link, including diagnostic and indication data.

For each piece of equipment monitored either directly by VHM or indirectly through the multiplex system, the Contractor shall identify all indications for which a road call is required. The data streams that may provide indications of critical importance, per manufacturer's recommendations, shall be monitored continuously by the VHM.

4.6.15.4 Data Transmission and Output

TOM shall provide indications of critical importance for display on MDTs and the Dispatch Center.

TOM shall make all data collected by the VHM subsystem available to the LAN via the Yard Access Point and a laptop computer via wireless download.

If proprietary gateways or translator boxes are required, the Contractor shall provide any such hardware and software needed to translate the data into a format that can be read and manipulated by the applications resident on the TTS Network.

4.6.15.5 Design Submittal

The Contractor shall submit a design proposal for the VHM subsystem that includes but is not limited to the following information <CDRL>:

- The specific pieces of equipment to be monitored by VHM
- Identification of the critical data that will be transmitted to the bus operator indication panel and the Dispatch Center
- For each piece of mobile equipment, the data monitored by the VHM subsystem
- Data outputs
- Description of needed software
- Equipment and wiring diagrams.

The Contractor's proposed design for the VHM subsystem shall be approved by TTS as required in the Specifications and Agreement.

4.6.16 Environmental Requirements

4.6.16.1 Power

All Onboard TOM equipment shall be protected against damage, loss, modification of data or software error caused by:

- Lower or higher voltage in the range of zero (0) to fifty (50).
- Reverse polarity of the input voltage.
- Temporary voltage variations associated with starting of coaches or operation of coach equipment and accessories.
- Vibration
- Condensation

The Onboard TOM bus equipment shall be designed to operate on buses providing 12 -volt direct current power. It shall also operate reliably from the bus' direct current power source of 10 to 18 volts, without malfunction.

4.6.16.1.1 DC to DC converter

12 VDC power is available for Onboard equipment.

4.6.16.1.2 Energy Conservation

The Onboard TOM equipment shall be designed to conserve battery power. Software strategies for energy conservation shall be utilized. Maximum current draw shall be 10 amps for the basic radio subsystem and a maximum of 20 (twenty) amps for all TOM features in operation and 0.8 amps when idle. Equipment shall have the ability to enter a "sleep" or idle mode when the vehicle run switch is turned off. TOM may enter into idle mode at a predetermined time after the run switch is turned off. Other arrangements, such as awakening equipment may be used. While in idle mode, the radio and other equipment such as the Onboard Processor may become active. TOM shall not be in idle mode for more that 45 minutes after the vehicle run switch is turned off. Contractor shall submit current draw information for the Onboard equipment while the Onboard subsystem is active mode (radio transmitting and not transmitting), idle, and "sleep" mode <CDRL>.

4.6.16.1.3 Power Conditioning

The Onboard TOM equipment power supply shall include adequate filters and components to regulate the voltage supplied by the bus and render it devoid of power spikes and noise which could contribute to erroneous registration, data generation and recording. Provisions shall include elimination of electronic interference caused by such items as, but not limited to florescent light power units, coach alternators, air conditioning units, fare collection equipment, and other accessories characteristic of TTS buses. Adequate protection against transient surges on the bus power supply shall be incorporated to the extent necessary to prevent damage to electronic components. All J1708 devices shall be of a wide DC input range covering 8-36 VDC input.

Sensing means shall be incorporated within equipment power supply(ies) to cause the Onboard TOM equipment to be switched off or transferred to internal battery support if the supply voltage increases or decreases to levels beyond the voltage tolerance supplied, and can result in erroneous registration, data generation or recording in memory. Loss or reinstatement of power shall not result in any corruption of the data in memory.

The Contractor shall be required to access fused power from a location identified by TTS for the Onboard TOM equipment. Suitable wiring shall be identified by the Contractor and approved by TTS prior to installation of the wiring by the Contractor.

4.6.16.1.4 Electromagnetic Interference

The Contractor's approach to electromagnetic compatibility (EMC) shall ensure that the electrical and electronic components and subsystems shall operate without being affected by or causing harmful electromagnetic interference. Protection shall be provided against radio frequency interference (RFI) emission sources, as well as internal conductive or inductive emissions.

While at transfer points to light and heavy rail, operation of the onboard equipment shall not be affected by the electromagnetic fields generated by traction power (catenary or third rail) at distances as close as 20 feet or by local high voltage power distribution lines at distances as close as 50 feet.

The Onboard TOM equipment shall be unaffected by interference such as radiation from bus equipment, including radio, lights, farebox, electronic destination signs, air conditioners, and generators. The TOM equipment shall not emit measurable EMI or RFI, except that required for radio or cellular communication, that produces harmful interference with any other onboard electronic device or system, compressed natural gas (CNG) system, methane and fire protection systems, or equipment outside the bus.

The Contractor shall certify, through testing, the electromagnetic compatibility of the onboard equipment to be furnished. In addition, the Contractor shall provide results of interaction analysis and testing of each item of equipment with regard to frequency distribution, amplitude, and harmonic content. If existing test certifications are not available,

then the testing shall be completed and results submitted for approval before the First Article Testing.

Additional inspection and testing required to determine EMI susceptibility and to assure EMC shall be performed during the environmental testing. All inspections, tests, and analyses submitted shall conform to the requirements of the following standards, as applicable:

- Electromagnetic Emission and Susceptibility Requirements for Control of Electromagnetic Interference: MIL-STD-461C;
- Electromagnetic Emission Susceptibility, Test Methods For: MIL-STD-462; and,
- For electrostatic discharge: IEC-801-2.

4.6.16.2 Environmental Requirements

The Onboard TOM equipment to be provided for installation and use onboard TTS' vehicles shall be designed, built, and installed for the harsh operating environment in which the Onboard TOM equipment is to operate. All TOM equipment shall be available at the instant of engine start, and remain operational throughout the time it takes the air conditioning and/or heating systems bring the vehicle to normal ambient conditions.

All Contractor-provided onboard equipment shall operate properly under the environmental conditions encountered onboard the vehicles including conditions pertaining to temperature, humidity, dust/dirt, power variations, vibration, condensation, and electrical interference. All Onboard TOM equipment housings shall be weather-proof and dust-proof.

As a result of bus interior cleaning, with pressure washing with hoses, and persons boarding in rainy and humid conditions, the interior of the bus can be expected to become wet. There may be accumulations of moisture, salt, mud, dust, detergents, solvents and tarnish. All Onboard TOM equipment shall be adequately protected to prevent degradation of operation under long-term exposure to these conditions. All onboard equipment shall be protected to prevent degradation from exposure to moisture or dust raised by interior cleaning.

The Onboard TOM equipment provided by the Contractor shall be tested and certified to meet the more stringent of the standards below:

- SAE J1455 and all standards contained therein
- Be able to operate and not suffer any degradation in performance under the following environmental conditions:

Storage Temperature	-25° to +150°F
Operating Temperature	+25° to +110°F
Thermal Shock	1° per minute drop in temperature over 15°F range between 110° and 60°

Relative Humidity Range	13% to 100% RH including condensation (Equipment need not function when wet, but must function properly under humidity conditions experienced inside Torrance Transit Systems vehicles)
Vibration	Operating: 1.5g RMS, 5 to 150 Hz Endurance: 8g RMS, 100 to 1,100 Hz
Shock	30g of 6 milliseconds
Airborne Dust	Up to 180 micrograms per cubic meter, with iron and salt particles
Inclination	0° to 10° off vertical
Water/solvents	Water spray on Equipment from cleaning floors and walls, industrial cleaning solvents, rain, mud, snow and slush will come in contact with Equipment
Primary Voltage	12 volts DC nominal; 10-18 VDC for short duration - up to 1000V spikes of a few milliseconds duration
Electromagnetic interference	Heater and air conditioning controls high voltage arcs (300V)
Grounding/Lightning	Good ground available/Lightning protection available to protect from high voltage (1000V) spikes from lightning

The Onboard TOM equipment shall comply with the following standards:

TEST/STANDARD	**MIL-STD 810C**	**MIL-STD 810D**	**MIL-STD 810E**
LOW PRESSURE	500.1/Procedure 1	500.2/Procedure 1	500.3/Procedure 1
HIGH TEMPERATURE	501.2/Procedure 1,2	501.2/Procedure 1,2	501.3/Procedure 1
LOW TEMPERATURE	502.1/Procedure 1	502.2/Procedure 1,2	502.3/Procedure 1
TEMPERATURE SHOCK	503.1/Procedure 1	503.2/Procedure 1	503.3/Procedure 1
SOLAR RADIATION	505.1/Procedure 1	505.2/Procedure 1	505.3/Procedure 1
RAIN	506.1/Procedure 2	506.2/Procedure 2	506.3/Procedure 2
HUMIDITY	507.1/Procedure 2	507.2/Procedure 2	507.3/Procedure 2
SALT FOG	509.1/Procedure 1	509.2/Procedure 1	509.3/Procedure 1
DUST	510.1/Procedure 1	510.2/Procedure 1	501.3/Procedure 1
VIBRATION	514.2/Procedure 8,10	514.3/Procedure 1	510.3/Procedure 1 Category 10
SHOCK	516.2/Procedure 1,2,3,5	516.3/Procedure 1,3,4,5,6	516.4/Procedure 4
APPLICABLE ENVIRONMENTAL STANDARDS		EIA 316-B Shock, Vibration, Dust, and Humidity.	

Any equipment installed on the exterior of the bus (including cable runs under the floor) shall be thoroughly sealed in a manner approved by TTS, such as to prevent leakage of rain or bus washing water, detergent and solvents into the bus throughout the life of the installation.

Additional standards may be provided in other sections of this Specification. In case of any conflict between standards, the Contractor shall meet the more stringent standard. All Onboard TOM equipment shall be suitable for the intended purpose.

4.6.16.3 Delivery

TTS shall be notified in writing at least two weeks in advance of each proposed delivery date of onboard equipment.

Onboard subsystem equipment shall be delivered to TTS in heavy-duty boxes. The exterior of each box shall be labeled, including manufacturer, equipment type, serial number, and date.

Onboard subsystems shall be delivered to an inside location designated by TTS. Each shipment shall be accompanied by an inventory list showing the quantities, serial numbers, and brief description of all devices.

4.6.17 Mobile Equipment Installation

The Contractor shall install all equipment purchased as part of the TOM. All hardware shall have the proper software loaded into the hardware and tested prior to the installation. All work is to be done in a workmanlike and expeditious manner, using industry standard practices and procedures, and conform to the City's Equipment Quality Installation Standards in Appendix K. The Contractor shall make itself aware of all applicable local and California State safety regulations, procedures and requirements. The Contractor shall adhere to the regulations, procedures, and requirements at all times while present on the City of Torrance property or in TTS vehicles or facilities.

The Contractor shall supply all of the work required for the proper installation of the radios and associated Onboard TOM equipment in TTS vehicles. All installation shall be performed at TTS' maintenance area unless otherwise approved by TTS. If installation is to take place off-site, Contractor must provide the installation site and shall reimburse TTS for the cost of transporting vehicles to the site.

The Contractor shall provide a detailed description of installation plans by class of vehicle. This shall include location of drilled holes, power feeds, and final location of all Equipment, final location of the MDT in relation to the driver's position, wheelchair access, etc. This shall be submitted for TTS approval no less than 60 days prior to installation <CDRL> of the TOM equipment.

One prototype installation of all Onboard TOM equipment shall be made on each TTS vehicle type. This installation shall be made at least two weeks prior to any other installation

work. TTS shall have the right to inspect and approve this installation before any other installation work is performed.

In the event that installation of any TOM equipment requires modification or replacement of bus equipment (including, but not limited to, handrails, power supplies, mounting brackets, etc.) Contractor shall be fully responsible to provide and install such replaced or modified equipment at no additional cost to Torrance Transit Systems.

The Contractor shall supply and install all the necessary wiring and cables, protective devices and mounting hardware necessary for the proper installation and operation of all TOM equipment purchased under this Agreement. All wiring in buses shall be properly grounded and protected from chafing, and installed in the plenum (air handling) spaces, except as approved by Torrance Transit Systems. Cabling shall be appropriately rated for the plenum installation. No PVC jacketed cable shall be utilized within the coach. Any undercarriage wiring shall be suitably protected against the road elements and fastened in a manner so as not to sag or interfere with normal bus operation and/or maintenance. No "butt connectors" shall be utilized under the bus. Exposed wire bundles inside the vehicle shall be securely anchored and carried in loom, plastic sleeving, or tightly laced. All cable assemblies shall be secured to minimize failure due to vibration and chafing. Grommetting shall be used in all holes used by the Contractor to minimize cable damage due to chafing. All wiring exposed within the passenger compartment of any bus shall be armored, isolated, and protected when going through drilled holes, through bulkheads, and within brackets.

Contractor shall install or verify previously installed DC wiring to ensure integrity, fusing and current capacity for the installation. All DC wiring shall be direct from the battery distribution block and shall include both A+ and A- cables. Further, both A+ and A- cables shall be adequately fused at both the battery end and the radio/TOM end with replaceable fuses. Signal and power cables shall not be intermingled in cable runs.

TTS shall make 2 vehicles available during nights and weekends for installation so that normal TTS service is not disrupted. A driver will be made available to move buses and other vehicles into position for installation and a service bay will be reserved for this purpose. A mechanic and supervisor may also be available during installation hours.

TTS shall have the right to inspect all installations for quality and workmanship, notwithstanding that such inspection or failure to conduct such inspection shall not relieve the Contractor of any responsibilities under this Agreement or Specification. TTS reserves the right to specify installation details on the job site.

Contractor shall maintain a log of installation events in hard copy and computer database. The log shall include a record of the installation locations, for each unit. The electronic copy shall be maintained in a form that is readable by Equipment and software programs furnished as part of this project. The log shall include but not be limited to: bus number in which the onboard equipment was installed, equipment model and serial number, date, software version (if applicable), and installing technician or supervisor. The log shall be available by authorized TTS personnel or TTS' representative at any time and delivered to TTS in hard

copy and electronic form when mobile installation work is complete <CDRL>. Contractor shall provide representative photographs of the installed units, for each bus type and supervisor vehicle.

Proposals shall describe the expected installation program in terms of schedule, requirements for TTS personnel involvement, availability of TTS facilities and vehicles, etc.

All removed radios and associated equipment from each vehicle shall be labeled by the vehicle number and unit number, boxed in containers, and provided to TTS, at a TTS designated facility for storage and disposal. Contractor shall use care in removing old radio equipment in order to maintain the intrinsic value for later sale or disposal and shall not damage the vehicle. Contractor shall be held accountable for any damage incurred. Cables shall be removed intact where possible and severed only when necessary.

A complete functional test shall be made of each item of installed equipment to confirm performance equal to that required by the Agreement or Specifications before releasing the item to service.

An Installation Functional Test Plan shall be submitted by the Contractor at the Final Design Review <CDRL>. No installation shall take place without approval of this plan by TTS.

4.7 YARD SUBSYSTEM

4.7.1 Wireless LAN

4.7.1.1 Wireless LAN Access Point

4.7.1.1.1 Type and Performance

The Access Point spread spectrum radio shall be configured for high volume; bi-directional transmission with the mobile system spread spectrum radios. The Access Point spread spectrum radio shall interface with the Yard Subsystem workstation for the transfer of data to vehicles within the yard, including route and schedule databases, passenger counts, vehicle health data, AVA data, and video data.

The wireless LAN Access Point shall operate as the master station with the mobile system client devices operating in a multi-drop configuration. IEEE 802.11g standard guidelines shall be used as a minimum standard. The wireless LAN Equipment shall conform to the Wireless Ethernet Compatibility Alliance certification standards for interoperability among IEEE 802.11g. High Rate products from multiple manufacturers. Frequency Hopping Spread Spectrum (FHSS) is an outdated technology and is not acceptable. The data rate shall be a minimum of 1 Mbps. Implementations other than IEEE 802.11g that use the 802.11 standards as the minimum acceptable performance guideline will be considered. A wireless LAN system that uses the 4.9 GHz band is preferred. The wireless LAN access point shall comply with the following:

- Minimum Range: 1200 ft
- Data Rate: 1 Mbps to 54.0 Mbps
- Operating Temperature: -10 to +60 C
- Interface: 10/100 Base T Ethernet
- Connector: RJ45 with CAT 5 cable LAN Interface
- Power: 110 VAC
- FCC Part 15 Compliant
- Protocol: IEEE 802.11g or approved alternate

4.7.1.1.2 Physical Configuration

The access point transceivers shall be of rugged construction, suitable for fixed installation in a bus yard, transit fueling building, and maintenance area environment.

4.7.1.1.3 Antenna

The spread spectrum radio antennas shall be heavy-duty, flat panel (patch) units as appropriate to cover the bus yard and maintenance facilities.

4.7.1.1.4 Access Point Data Security

Two forms of security shall be used. The Access Point (AP) shall be configured to convert clear text data arriving from the host into cipher text before transmitting it over the wireless medium. The AP or the server shall make authentication checks on all wireless clients that wish to gain connectivity, using a challenge and response algorithm and consulting an access list of approved clients. Any access list(s) shall be hosted on the AP or server included in the proposal. Each unauthorized access attempt shall be logged.

4.7.1.1.5 Access Point Network Interface

The Wireless LAN AP Network interface shall provide appropriate filtering for traffic at full Ethernet wire speeds. The network interface shall incorporate protocol filters and broadcast traffic filters with adjustable bandwidth allocation. The protocol filter shall limit messages to IP format and filter out any other protocol from running on the wireless LAN. The broadcast filter shall block broadcast messages from the wireless LAN. The wireless LAN to TOM network bridging shall be configured to allow only packets to clients that the AP knows to exist in the Wireless LAN behind the wireless bridge. The access point unit will adaptively select the bandwidth allocation for each wireless LAN session with a client, based on the best rate for communication with no retries, using a range vs. speed trade off method.

A wireless network management tool shall be provided with TOM. The tool will be used to monitor and maintain the wireless system. It will have the capability to log a client on and off of TOM, and put the client into a maintenance test mode. This tool shall provide reports on wireless client status, fault indications and last login with the AP.

4.7.2 Yard Workstation

The Yard Subsystem shall include a server/workstation that shall be located in the maintenance area.

The TOM Yard Server/Workstation shall perform dual functions as the server for the TOM Wireless LAN and as a TOM workstation. The Yard Server/Workstation will be used by TTS personnel to manage wireless transfer of data to and from the vehicles, and the transfer of data to and from the TOM Network interface. The workstation shall be used by maintenance and supervisor personnel to view bus locations and status; review vehicle health information, review video retrieved from the buses, generate management reports, and possibly to enter bus to line assignments.

The workstation shall use the most current commercial technologies for the processor, RAM and hard drive memory, video and audio cards, DVD and CD-RW subject to approval by TTS. The workstation shall include one 22-inch LCD monitor.

4.7.3 TOM Local Area Network

The TOM local network at the bus yard shall be configured as per Section 3.5.3.2 of this Specification. Standard networking hardware, including switches, bridges, and routers shall be utilized that incorporate SNMP management. The TOM LAN hardware shall be managed from the TOM System administrator workstation at the Dispatch Center.

4.7.4 Installation Requirements

The Contractor shall make itself aware of all applicable Torrance Transit Systems and California State safety regulations, procedures and requirements. The Contractor shall adhere to the regulations, procedures, and requirements at all times while present on the City of Torrance property or in TTS vehicles or facilities.

The TOM Yard Subsystem shall be installed in a manner to protect the equipment from vandalism and the elements, and yet provide reasonable access. Connectors that are exposed to the elements shall be of the weather pack type. The installed Yard Subsystem equipment shall have no sharp edges or corners.

The Contractor shall install the Yard Subsystem during Torrance Transit Systems maintenance operating hours. The Contractor shall use installation drawings that have been prepared and submitted to and approved by Torrance Transit Systems <CDRL>. Design drawings shall be scaled and shall show installation details of all Equipment, cables, conduits, power connections, and associated work. The Contractor shall coordinate the schedule for installations at the yard with Torrance Transit Systems a minimum of 14 days prior to installation. This is a necessary time span to ensure the facilities will be available for the installation. The Contractor shall be responsible for supplying all necessary tools, fasteners and miscellaneous materials required for installation of TOM equipment. The Yard Subsystem installation shall be inspected by Torrance Transit Systems personnel prior to final acceptance.

4.7.4.1 Wireless LAN Access Point Installation Location

The access point transceivers shall be installed in the bus yard. The number of access point transceivers and the mounting locations shall be calculated by the Contractor such that the Wireless LAN in the bus yard shall meet the radio coverage requirements. Calculations shall be submitted to Torrance Transit Systems for approval <CDRL>. The Contractor shall provide the cable connection from each AP to the TOM Wireless LAN.

4.8 SUPERVISOR SUBSYSTEM

4.8.1 Voice Communications

The Supervisor subsystem shall use the TTS voice radio system to enable supervisors to place voice calls to individual buses, dispatchers, and other supervisors. The voice communication equipment shall meet the requirements listed in Section 3.3.1. TTS will provide portable and mobile radios for the Supervisor subsystem.

4.8.2 Data Radio Communications

The Supervisor subsystem shall utilize the same data radio system and data radio equipment used by the TTS buses for data communications. The data radio equipment for the Supervisor subsystem shall meet the requirements in Sections 3.3.2 and 4.6.8.

4.8.2.1 Data Antenna and Feed Line

The Contractor shall provide and install a mobile antenna that is compatible with the data modem and durable to withstand the rigors of the public transportation environment.

4.8.3 Automatic Vehicle Location

The Supervisor subsystem shall include the same Automatic Vehicle Locator subsystem used for the TTS buses and shall meet the same the requirements. TOM shall track supervisor locations with a reporting cycle of sixty seconds or less.

The GPS receiver shall meet the requirements in Section 4.6.11.1 of this Specification. The GPS acquisition time shall be four minutes or less for a cold start and less than thirty seconds for a warm start. The output data at a minimum should include latitude, longitude, speed, time and direction of travel.

4.8.4 Environmental Requirements

The Supervisor Subsystem shall meet the following vehicle environment requirements:

- Meet operational requirements while exposed to temperatures from 45 to 105 degrees F and withstand 20 to 140 degrees F while not operational
- Meet operational requirements while exposed to temperatures from humidity of 30% to 80% and withstand 30% to 90% while not operational
- Withstand exposure to dust conforming to MIL-STD-810E 510.3
- Withstand exposure to liquids conforming to MIL-STD-810E 506.3
- Withstand vibration of 3g and shock of 20g and conform to MIL-STD-810E 516.4
- Shall not adversely impact vehicle electronics nor be adversely affected by vehicle electronics
- Shall not emit signals that interfere with AM/FM radio reception or with portable/mobile voice communication devices
- Shall be shielded to protect it from signals emitted by the vehicle and other in-vehicle equipment (including cellular phones) and external sources of EMI such as power lines or transit catenary
- Shall be capable of being mounted in vehicles with driver and passenger airbags and shall be airbag compliant
- Operate with the standard vehicle electrical system without the need for converters or inverters. The current draw shall be minimized, particularly while the vehicle is inactive. The Contractor shall submit power draw calculations <CDRL>.
- Include protection to avoid damage if the subsystem were to be incorrectly installed
- Tolerate voltage variations and electrical noise found in normal commercial vehicle electrical systems without losing or altering stored or displayed information
- Equipment shall conserve vehicle battery, including use of semi-active modes similar to the Onboard TOM subsystem.
- Equipment shall shut down X minutes after ignition shut off. X shall be a system settable parameter.
- Protection from accidental voltage reversal
- Full functionality during starter motor operation

4.9 ROAD SUPERVISOR SUBSYSTEM (OPTION)

4.9.1 Voice Radio

The voice radio for the Road Supervisor subsystem shall use the TOM voice radio network to enable supervisors to place voice radio calls to individual buses, other transit supervisors and lead bus operators, and the Dispatch Center. . The voice radio shall meet the same requirements as the voice radios in the buses.

4.9.2 Wireless Data Communications

A commercial wireless data service shall be used to accommodate data communications from the Dispatch Center to the Road Supervisor MDCs. In addition to the area of coverage, the maps shall show the site(s) that are used to provide the coverage. Minimum acceptable

signal level is -95dBm, unless the Contractor's design shows that their system can operate at a lower level. Coverage maps and system operational characteristics shall be provided in the Proposal and Preliminary Design, as stated in Section 10.

The commercial wireless data modem shall be FCC type accepted for transmission of digital signals. The wireless data service shall have a blocked error rate of less than 5% over 95% of the coverage area. Effective throughput and blockage calculations shall be provided in the Proposal and Preliminary Design, as stated in Section 10.

All control of the modem such as channel selection shall be handled automatically by the modem. No manual channel selection by the user shall be required.

Any encryption that is proposed shall include a description, including type of encryption used, key size and if the encryption is always active.

The Contractor shall be responsible for registering the modems with the service provider for the communications service and obtaining and programming the IP address and multicast address for each modem. All modems shall be configured for the same multicast group. The Contractor shall act as liaison to the service provider services for Torrance Transit Systems. The Contractor shall interface with the designated service provider to establish the data service.

4.9.2.1 Data Antenna and Feed Line

The Contractor shall provide and install a mobile antenna that is compatible with the data modem and durable to withstand the rigors of the public transportation environment

4.9.3 Mobile Data Computer (MDC)

TOM shall assign a unique identifier to each Mobile Data Computer (MDC). Each transmission to the host shall include the unique identifier. Each operator shall have a unique password.

The MDC shall utilize a commercially available operating system, such as Windows 7. Terminal emulation may be used.

4.9.3.1 Mobile Data Computer Specifications

The MDC shall use the most current commercial technologies for all components including the processor, RAM and hard drive memory, video and audio cards, DVD and CD-RW; and shall use a current Windows operating system; subject to approval by TTS. The MDC shall have sufficient RAM and hard drive space for the applications used by the Road Supervisor subsystem. The physical configuration of the MDC shall be that of a laptop computer, and it

shall be semi-permanently mounted. The MDC shall be fully configured and ready to operate with all required cabling, vehicular chargers, mounting brackets and frames.

The MDC shall incorporate manually operated level controls to adjust audio level, video display intensity, keyboard lighting and LED or indicator intensity. Any module of the MDC (processor, screen, keyboard) should be removable/replaceable without replacement of the entire unit.

The MDC shall be equipped with a self-diagnostic routine that is executed upon power-up of the unit. The Proposer shall indicate the functions performed by the self-diagnostic routine and how failures are indicated to and interpreted by the user.

Messages shall generate an audio and visual alert to the supervisor. User shall have the capability to define which alert(s) apply to the MDC. Audible alerts shall be a single or multiple beep and adjustable from loud to off.

The MDC shall enable users to perform data entry, word processing, etc. functions with or without host communications.

4.9.3.1.1 MDC Screen

The MDC screen shall have or be capable of displaying the following:

- Color
- Blinking text
- Highlighted text
- Underlined text
- Reverse Video
- Resolution (1280 by 1024 minimum)

The screen brightness and contrast shall be adjustable for viewing in ambient light (direct sunlight to darkness). The minimum NIT level shall be candela/sq. meter. To extend screen life, an automatic (timed) and manual screen saver and sleep mode shall be provided.

During normal operations, the following status information shall always be displayed on the screen:

- Message alert
- Number of pending messages
- Number of stored messages in message queue.
- Communication verification and other MDC operational status including communication transmission signal strength.

Standard keys functions shall be provided for the following:

- Clear display
- Display next message

- Clear/Erase message
- Store/Recall message from message queue
- Clear/Erase operator's entire message queue
- Print/Routing

4.9.3.1.2 Keyboard

The keyboard shall be standard QWERTY format with 87 keys and Windows-ready. The keyboard shall be protected from dust, smoke, moisture and liquid spills and other foreign particles that would eventually render it inoperable.

The keys shall be standard size and have full travel. Keys shall be lighted or backlighted for night use. All keys, including user definable keys, shall be equipped with keycaps engraved with the name of its function(s) or character(s). If the key produces a different character or function in the shifted versus un-shifted position, both character/functions shall be shown on the keycap. Special function keys shall be designed for differentiation to the touch.

4.9.3.1.3 Other Devices/Features

The MDC shall be equipped with a minimum of one parallel and three 2.0 USB connections for attachment of additional peripherals. The MDC shall be capable of accepting a digital camera input.

The MDC shall be capable of displaying maps of Los Angeles County and the neighboring counties and map of the cities within LA County. At a minimum, maps shall display incidents, street names, addresses, and business names. The GIS software installed shall provide zoom capability.

4.9.3.1.4 Vehicular Mounting

The MDC shall not in any way interfere with vehicle operation, or create a hazard to personnel who need to exit the vehicle from any position in the vehicle. To deter theft, the MDC mounting shall require special tools or a key to remove the unit. The Contractor shall submit detailed mounting arrangement plans for each model of supervisor vehicle for TTS approval<CDRL>.

If fixed mount MDCs are proposed, the mount shall accommodate dual air bags and allow viewing by either front seat passenger. If swivel mount MDCs are proposed, the mount shall accommodate dual air bags design and allow viewing by either front seat passenger and shall have a positive means of locking it in the desired position to prevent shifting while the vehicle is in motion. The Contractor shall file the paperwork required if the front passenger air bags must be disabled.

The Proposer shall submit information on the proposed mounts and are encouraged to provide multiple options for various vehicles, i.e. car, van, truck, etc.

4.9.3.2 Automatic Vehicle Location

The Road Supervisor Subsystem shall include an Automatic Vehicle Locator subsystem that uses GPS technology with differential correction. TOM shall track supervisor locations with a reporting cycle of at least every minute so that supervisor locations can be made available as requested at the Dispatch Center. The AVL subsystem shall be integrated with the mobile computer and interface with the TOM GIS/mapping software applications, as defined for bus AVL.

The GPS receiver shall meet the same requirements as the GPS receivers onboard the buses.

4.9.4 Environmental Requirements

The Road Supervisor Subsystem shall meet the following vehicle environment requirements:

- Meet operational requirements while exposed to temperatures from 45 to 105 degrees F and withstand 20 to 140 degrees F while not operational
- Meet operational requirements while exposed to temperatures from humidity of 30 to 80% and withstand 30 to 90% while not operational.
- Withstand exposure to dust conforming to MIL-STD-810E 510.3.
- Withstand exposure to liquids conforming to MIL-STD-810E 506.3.
- Withstand vibration of 3g and shock of 20g and conform to MIL-STD-810E 516.4.
- Shall not adversely impact vehicle electronics nor be adversely affected by vehicle electronics. The MDC shall meet or exceed EIA204 and RS-374 mobile radio standards.
- Shall not emit signals that interfere with AM/FM radio reception or with portable/mobile voice radios.
- Shall be shielded to protect it from signals emitted by the vehicle and other in-vehicle equipment (including cellular phones) and external sources of EMI such as power lines or transit catenary.
- Shall be capable of being mounted in vehicles with driver and passenger airbags and shall be airbag compliant.
- Operate with the standard vehicle electrical system without the need for converters or inverters. The current draw shall be minimized, particularly while the vehicle is inactive. The Contractor shall submit power draw calculations <CDRL>.
- Include protection to avoid damage if the subsystem were to be incorrectly installed.
- Tolerate voltage variations and electrical noise found in normal commercial vehicle electrical systems without losing or altering stored or displayed information.
- Equipment shall conserve vehicle battery, including use of semi-active modes similar to the Onboard TOM subsystem.
- Equipment shall shut down X minutes after ignition shut off, whereX shall be a system settable parameter.
- Short-term battery backup or equivalent to preserve critical information during brief power failures or during vehicle start-up. Capacitor only circuitry shall not be utilized to meet this protection requirement. (MDC only)
- Protection from accidental voltage reversal.

- Full functionality during starter motor operation.

4.10 TRAVELER INFORMATION SYSTEM

TOM shall calculate time of arrival at the next bus stop for each bus for the Traveler Information System. Updated bus locations and time of arrival information shall be transferred to the TDB on a continuous basis or at least once every minute. TOM shall provide updated time of arrival information to electronic display signs and monitors at least once every minute. TOM shall provide AVL and time of arrival information for all buses in XML format for an interface to the RIITS network and the Southern California 511 system.

4.10.1 Electronic Display (Option)

The display signs shall be single or double row amber LED signs. The characters to be displayed shall include the entire 128 ASCII character set. The character size shall be at least 4 inches for display signs. The maximum luminous intensity of each LED (pixel) shall exceed 2900 millicandelas (MCD). In addition, the display signs and monitors shall meet ADA requirements for character size and general readability in bright sunlight and low light conditions.

The displays shall be of rugged construction, reliable, maintainable, and suitable for the designated installation location. The Contractor shall utilize vandal resistant enclosures and the faceplate shall be scratch resistant. Cable connections to the signs shall be concealed as much as possible. The Contractor shall submit the installation details for the Displays at each location for TTS approval <CDRL>.

4.10.1.1 Communication

The Contractor shall provide a communication link between the TOM Computer Subsystem and the electronic display signs and monitors. Details of the communication link shall be provided in the Proposal and Preliminary Design, as stated in Section 10. Should the communication link require ongoing subscription costs, the Contractor shall act as liaison to the service provider for TTS. The Contractor shall interface with the designated service provider for the purpose of establishing service.

4.10.1.2 Power

The electronic display signs and monitors shall utilize AC power wherever possible. The Contractor shall connect the electronic signs and monitors to sources of AC power identified by Torrance Transit Systems. The Contractor shall furnish a battery backup unit for each display.

The proposers shall provide an option for solar powered displays.

4.10.1.3 Environmental Requirements

All electronic display signs and monitors shall be certified to function in an outdoor environment and shall not be affected by the following environmental conditions:

- Min. to max. temperature: 20°F to 120°F for outdoor displays, 50°F to 100°F for indoor displays
- Relative humidity: 15% to 95%, non-condensing for outdoor displays, 20% to 80%, non-condensing for indoor displays
- Rainfall: up to 6 inches per hour, for outdoor displays
- Freezing precipitation: up to 3 inches per hour, for outdoor displays
- Wind speed: up to 80 mph, any direction, for outdoor displays
- Sunlight: None to full, direct, for outdoor displays
- Atmospheric pollutants: Characteristic of the Los Angeles area, including salt, dust and corrosive or base chemicals.

The Contractor shall provide fans, heat sinks, heaters and other devices necessary to control internal temperature and humidity conditions in order to maintain proper operation of the displays. Provisions shall be installed to maintain an internal operating temperature range between the minimum and maximum operating environment temperatures of internal components, as specified by the display manufacturers and as necessary to ensure display reliability. Solar load and heat generated by internal components shall be added to the operating environment. Means shall be provided to detect failure of any cooling device and provide for shutdown of the displays and notification of maintenance through to the Dispatch Center.

Equipment enclosures shall be designed and constructed to prevent the entry of water when the door is closed during a heavy rainstorm, under maximum rainfall and maximum sustained wind speed as defined above and as well as from pressure washing. Any water that does enter the equipment shall be routed out of the equipment and shall not cause short circuits, failures, or other damage. Sufficient filtration shall be provided to minimize the intrusion of dust, including brake dust (metallic particles) resulting from the operation of vehicles at a close proximity, through slots and other openings. Any dust that does enter the displays shall not affect its operation.

All exposed surfaces of the system components shall be unaffected by brushes, detergents, and cleaning solvents normally use by maintenance crews. All exposed surfaces shall also be resistant to ultraviolet radiation and air contaminants.

4.10.1.4 Display Signs and Monitors Installation

The Contractor shall install all display signs and monitor equipment furnished as part of TOM. Contractor shall supply all cabling and shall install the cabling and other connections to existing utilities.

Prior to the installation, the Contractor shall review the installation drawings that have been prepared, submitted, and approved by Torrance Transit Systems <CDRL>. The Contractor shall be aware of all applicable local and State of California safety regulations, procedures and requirements and shall conform in all aspects of installation. The Contractor shall obtain all necessary permits and licenses for the installation and operation of the displays.

4.11 BUS SIGNAL PRIORITY (OPTION)

The Contractor shall install all onboard BSP equipment furnished as part of TOM.

4.11.1 Message Format

The bus to intersection BSP message format shall conform to the LA Metro protocols as detailed in the following table which shows the standard Bus Signal Priority message formats. There are two protocols, Revision 1 Pilot Project Protocol and Revision 2 Metro Rapid Protocol. Messages shall be sent from the bus to the intersection traffic signal controller for checking in, then five seconds later as a position update or confirmation message, and then a third time for the check out message as the bus enters the signalized intersection. In the event that the first check-in message is not received, the position update message serves as a backup for the original check-in message.

Each of the three messages shall be modified by the addition of the DTGP Action byte, which shall be sent from the traffic signal controller for use by the BSP Network Monitor.

The Countywide Signal Priority architecture has two modes of operation:

- Mode 1 Schedule Based: The on-board data processing system determines if the bus is more than X minutes behind schedule, where X is a system settable parameter. The determination is based on a comparison of actual time versus scheduled time at the last timepoint. As the bus approaches the intersection, three messages are sent from the bus to the intersection traffic signal controller. The first message is sent from the bus to the intersection traffic signal controller for checking in, then five seconds later as a position update or confirmation message, and then a third time for the check out message as the bus enters the signalized intersection. The bus-to-intersection message format must conform to the Revision 1 Pilot Project Protocol. The traffic signal controller determines if priority can be granted based on the status of the traffic signal and rules established for granting priority by the local agency.

  If it is determined that priority will not be requested based on the comparison of actual time versus scheduled time, the check in, position update, and checkout messages are sent from the bus to the intersection controller as position updates only.

- Mode 2 Headway Based: For the Mode 2 Headway Based operation, the on-bus computer system sends the check-in, position update, and checkout messages at each intersection where priority will be requested. The bus-to-intersection message format

must conform to the Revision 2 Metro Rapid Protocol. The Metro Rapid Protocol includes fields for the bus route and scheduled headway. The traffic signal controller tracks the actual headway between the buses checking in on the same route and direction, and compares it against the scheduled headway. If the actual headway is more than Y minutes greater than the scheduled headway, where Y is configurable by the user, the traffic signal controller will make a decision to grant priority based on the status of the traffic signal and rules established for granting priority by the local agency.

The table below shows the standard Countywide Signal Priority message format. As noted above, there are two protocols, Revision 1 Pilot Project Protocol and Revision 2 Metro Rapid Protocol. This message will be sent from the bus to the intersection traffic signal controller for checking in, then five seconds later as a position update or confirmation message, and then a third time for the check out message as the bus enters the signalized intersection. In the event that the first check-in message is not received, the position update message serves as a backup for the original check-in message.

The check-in, position update, and check-out messages with Action Taken field added are forwarded to the CSP Network Monitor IP address as soon as possible after the request for priority messages are received by controller. The Action Taken field for the repeated check-in and position update messages shall be zero or, if the action taken is known such as under certain circumstances when priority is being denied, may be filled in the appropriate Action Taken code. The Action Taken field for the repeated check-out messages shall be filled in with the appropriate action taken code.

In order to support the bus-to-intersection message format, certain data items will be entered by the controller front panel screen display(s). The data items are city code and intersection number, designation of input serial or ethernet port where messages are received and then repeated, designation of the CSP Network Monitor IP address where required, and any factors required to support conditional priority based on actual versus scheduled headway variations for the Metro Rapid Protocol.

The messages received start and end with Hex 0x7e. The data fields will not contain Hex 0x7e (decimal 126) or Hex 0x7e (decimal 125). Any 0x7e in a data field will be replaced by 0x7d0x5e where 0x7d is the escape byte and 0x5e is 7e with bit 5 reversed. Any 0x7d in a data field will be replaced by 0x7d0x5d. Messages received by the controller from buses requesting priority will include the replacements for 0x7d and 0x7e as described above, where these disallowed values are included in a data field. Messages repeated by the controller, including the Action Taken field, will replace any 0x7d and 0x7e in a data field with the replacements as described above.

Signal Priority Message Format Table

Field	Data	Description
1	Hex 0x7e	Start Flag
2		Address Packet, Variable length (1-3 bytes)

3	Hex 0x03	Control (send data no response)
4	Hex 0xc3	Initial Protocol Identifier (IPI)
5	Hex 0x8N	Command (0x80 STMP + 0x05 Bus Status with N Data bytes; N=5 for Pilot Project Protocol, N=8 for Metro Rapid Protocol)
6	Hex 0x0R	Protocol Revision (R=1 Pilot Project Protocol; R=2 Metro Rapid Protocol)
7		Data, Bus Identifier (Two bytes) MSB, LSB
8		Data, Bus Status
9		Data, Bus ETA
10		Data, DTGP Action (See Note Below)
11*		Scheduled Headway (One byte) - Metro Rapid Protocol Only
12*		Bus Route (Two Bytes) – Metro Rapid Protocol Only
13		CRC (Two bytes) MSB, LSB
14	Hex 0x7e	End Flag

Definition of Data Fields

Field		Contents
2	Address Packet	A two or three byte field as follows: Byte 1, Address low order byte Byte 2, Address high order byte (if needed; up to 8,191 identifiers using two bytes) Byte 2 or 3, City code (up to 127 codes) Byte 4, Not used Byte 5, Not used Bits 8 7 6 5 4 3 2 1 Byte 1 A6 A5 A4 A3 A2 A1 G E=0 Byte 2 A13 A12 A11 A10 A9 A8 A7 E=0 Byte 3 C7 C6 C5 C4 C3 C2 C1 E=1 A (nth) = Address C (nth) = City Code G = Group (Always zero) E = Extension City code is always the last byte, as indicated by E=1. Address is in bytes 1 and 2 (0-8191) or just byte 1 (0-63).
5	Hex 0x8N	Command (0x80 STMP + 0x05 Bus Status with N Data bytes) N=5 for Pilot Project Protocol N=8 for Metro Rapid Protocol)
6	Hex 0x0R	Protocol Revision R=1 Pilot Project Protocol R=2 Metro Rapid Protocol
7	Data, Bus Identifier	Bus Identifier (two bytes) MSB, LSB
8	Data, Bus Status	Bits

1 N/B Bus direction
2 S/B Bus direction
3 E/B Bus direction
4 W/B Bus direction
5 Position update
6 Check-out
7 Check-in
8 Priority Request

9	Data, Bus ETA	Estimated Time of Arrival in Seconds (0-255)
10	Data, DTGP Action	Bits 1 Hold the Green Phase (Bus arrives during green) 2 Early Green Return (Bus arrives when not green) 3 Special Operation (Future; queue jump or skip phase) 4 Demand Override 5 Manual Override 6 Table Override 7 Priority Override 8 Preempt Override NOTE: Data field number 10 (DTGP Action) will not be sent by the bus to the intersection when requesting priority and is reserved for recording the action taken by the traffic signal control equipment and going back to the CSP Network Monitor. The DTGP Action Taken byte will be added to each of the bus check in, position update, and checkout messages by the intersection controller and forwarded to the CSP Network Monitor. NOTE: The DTGP Action bits may be specific to the controller firmware.
11	Scheduled Headway	Scheduled Headway (1-255 minutes; zero indicates not being used or data not available) Metro Rapid Protocol Only.
12	Bus Route	Bus Route Number (two bytes) (1 or greater) Metro Rapid Protocol Only. NOTE: Controller must track actual headway by bus route and direction and compare against scheduled headway by bus route and direction.

5 PROJECT MANAGEMENT REQUIREMENTS

The following Project Management elements shall be incorporated as a key component of the project.

5.1 PROJECT MANAGEMENT PERSONNEL

The scope, duration and size of this project requires the Contractor to create an effective Project Management team to ensure the success of the work.

5.1.1 Project Manager

The Contractor shall establish a Project Manager, who shall be highly responsive to the needs of TOM as required in these Specifications and subject to Torrance Transit Systems acceptance. The Project Manager shall coordinate design and engineering activities and provide a technical liaison to Torrance Transit Systems. This person shall be highly competent and fully qualified in all aspects of the System.

The Project Manager shall be identified to Torrance Transit Systems, within seven (7) days after notice to proceed.

5.1.1.1 Authority

The Project Manager shall have the contracting authority to issue and approve purchase orders and to contractually bind the Contractor. The Project Manager shall have the authority to assign and schedule Contractor personnel to perform all of the Work required by this Agreement, and act as Contractor's representative for dispute resolution.

5.1.1.2 Responsibility

The Project Manager shall provide a single point of contact for Torrance Transit Systems to resolve all issues related to this Contract. The Project Manager shall be responsible for directing all subcontractors' designs and work. The Project Manager shall conduct weekly project status meetings with TTS staff and provide monthly updates for the City Council.

5.1.1.3 Project Understanding

The Project Manager shall have a full and complete understanding of the Contract Documents and site conditions sufficiently to provide adequate direction for coordination of work.

5.1.1.4 Qualifications

The Project Manager shall have at least five years experience in the implementation and management of mobile ITS projects, with at least one completed SmartBus project assignment for a fleet in excess of 50 vehicles. Torrance Transit Systems shall be the sole

determinant of the suitability of the proposed Project Manager's qualifications. Torrance Transit Systems reserves the right to have the Project Manager replaced if these qualifications are not met.

5.1.1.5 Availability to the Project

The Project Manager shall be available to TTS on a twenty-four hour per day, seven days per week basis via telephone and pager and shall respond promptly to any reasonable TTS request. Coverage of this requirement by any alternates shall be subject to approval by TTS.

The Project Manager shall be on site during all significant project events, as necessary to facilitate meetings, project activities, and information flow between the Contractor and TTS, and as requested by TTS. The Project Manager shall be on site during the installation and testing of TOM. In no case shall it be considered acceptable for the Project Manager to be on site less than five (5) days per month.

5.1.2 Senior Technical Staff Member

The STSM shall be available to the Project within seven days after NTP.

5.1.2.1 Responsibility

The STSM shall act as a technical resource for coordinating all system design and implementation issues. The STSM shall check each technical submittal prior to its being sent to TTS for approval. The STSM shall check factory wiring and field work to assure quality.

5.1.2.2 Project Understanding

The STSM shall have a complete understanding of the technical requirements of the Contract Documents and site conditions sufficiently to provide design direction and to determine compliance of the Contractor's design submittals and work.

5.1.2.3 Qualifications

The STSM shall be a Licensed Professional Engineer, qualified to practice electrical engineering, or an engineer who qualifies as acceptable to TTS. The STSM will have a minimum of five years of experience in coordinating engineering and administrative support activities for mobile radio and computer aided dispatch projects. TTS shall be the sole determinant of the suitability of the proposed STSM's qualifications. TTS reserves the right to have the STSM replaced if these qualifications are not met.

5.1.2.4 Availability to the Project

The STSM shall be on site during all significant project events, as necessary to facilitate meetings, project activities, and information flow between the Contractor and TTS, and as

requested by TTS. In no case shall it be considered acceptable for the STSM to be on site less than five (5) days per month.

Coverage of this requirement by any alternates shall be subject to approval by TTS.

5.2 PROJECT MEETINGS

5.2.1 Attendance

The Contractor's Project Manager and STSM shall attend Progress Meetings held monthly and conduct weekly teleconference calls. The Contractor's Project Manager and STSM shall conduct a Project Kickoff Meeting with Torrance Transit Systems TOM stakeholders, Steering Committee, and the TOM Consultant Manager. The Contractor's Project Manager and STSM shall attend additional meetings, as requested by TTS and the TOM Consultant pursuant to the coordination of the Work.

5.2.2 Location

Progress meetings shall be held at TTS facilities unless otherwise specifically approved by TTS. Other meetings shall be held at a mutually agreeable location, conducive to the topic of the meeting. For any project meetings conducted by conference call, the Contractor shall, at the Contractor's expense, provide a conference call-in number.

5.2.3 Meeting Minutes

The Contractor shall prepare minutes for each meeting, unless specifically instructed otherwise by Torrance Transit Systems <CDRL>. The Contractor shall prepare the minutes and distribute them to the attendees within one week after the meeting. Minutes of the meetings shall include names of attendees, significant proceedings, decisions, unresolved issues, and a list of information requested by Torrance Transit Systems. The minutes shall be of sufficient detail to record any decisions made at the meeting and any follow-up actions required. The minutes shall include a summary of open action items, the party responsible for each, scheduled date for the action, and the respective resolution. Contractor shall provide a rolling project report, adding and deleting items as necessary.

5.2.4 Agenda

The Contractor shall prepare an agenda for each progress meeting <CDRL>. The Contractor shall provide a draft agenda to Torrance Transit Systems at least one week prior to each meeting and request that TTS add any additional items. Review of the previous meeting minutes and any outstanding action items shall be included on the agenda for each meeting.

Each progress meeting agenda shall also include the item, "Additional Torrance Transit Systems Issues and Concerns."

5.3 SCHEDULE

5.3.1 Detailed Contract Schedule

The detailed contract schedule shall be a critical-path-method schedule constructed using Microsoft Project or other software application acceptable to Torrance Transit Systems. The detailed contract schedule shall show each activity, including interface activities, for completion of the Work, and shall be properly ordered and sequenced. If a phased approach is recommended by the Contractor, Contractor shall cite an example where the recommended phased approach was successful. Three printed copies and one electronic copy of the detailed contract schedule shall be submitted for Torrance Transit Systems approval within 45 calendar days after NTP <CDRL>.

5.3.1.1 Task Duration Limits

The detailed contract schedule shall be sufficiently detailed to preclude the use of activity durations greater than 20 working days. Activity durations shall include allowances for lost time and inefficiencies.

5.3.1.2 Task Designations

Each task designation shall delineate the phase or stage of the Work, and the component of the Work such as design, submittal, submittal review, procurement, fabrication, delivery, installation, and testing.

5.3.1.3 Task Details

Where appropriate to the understanding of the task, additional details shall be provided, such as:

- A clear description of the activity, including its location.
- The duration expressed in full working days.
- A responsibility code denoting the Contractor, a subcontractor, Torrance Transit Systems, a government Agency, or a utility is performing the activity.
- The quantity of material, in units.
- The integer percent complete representing the installed progress.
- The actual start and finish dates where applicable.
- Unless specifically agreed to in writing by Torrance Transit Systems, Contractor is responsible for all Work to complete any task.

5.3.2 Critical Path

The detailed contract schedule shall show a clear and definable critical path(s) for the Work and each specified milestone. Requirements and events which impose limitations, as well as dates and milestones which constrain the time, shall be clearly identified. Days of float time shall be shown. Items that require Torrance Transit Systems inputs and responses shall be clearly identified.

5.3.2.1 Updates

The detailed schedule shall be updated monthly to show actual progress and changes to projected dates. Each update shall include a narrative describing the changes made since the last update. Each update shall be provided to Torrance Transit Systems within 5 working days from the month end cut-off date and submitted with each invoice. Three hardcopies and one electronic copy shall be provided <CDRL>.

5.3.3 Four-Week Rolling Schedules

The four-week rolling schedule shall show one week of historical information and three weeks of planned activities in support that are consistent with the detailed contract schedule.

5.3.3.1 Format

The four-week rolling schedule shall be presented as a chart with tasks along the left side and days along the top of the table. A shaded bar or "X" entered in the chart shall indicate the work to be performed on each day for that task.

5.3.3.2 Task Detail

The level of detail shown on the four-week rolling schedule shall be greater than the level shown on the detailed contract schedule. In general, it shall show the Work to be done each day and the location(s) where the work will be done and by whom. Work done in buses and other vehicles shall be identifiable uniquely or as part of an easily traceable group of buses. Work that requires a Torrance Transit Systems input or response shall be clearly identified.

5.3.3.3 Updates

The four-week rolling schedule shall be updated weekly and provided to Torrance Transit Systems by the end of the first day of each active week. Three printed copies and one electronic copy shall be provided <CDRL>.

5.4 SUBMITTALS

5.4.1 General

This Section describes general requirements and procedures for preparing and transmitting information to Torrance Transit Systems for review, acceptance or approval. Detailed

requirements for individual submittals are specified in the applicable sections of the Specifications.

5.4.1.1 Scheduling of Submittals

Transmit submittals sufficiently in advance of Contract requirements to permit at least twenty-one (21) calendar days for review, checking and appropriate response by Torrance Transit Systems or designated representative.

5.4.1.2 Transmittal Forms

Furnish the transmittal forms sequentially numbered and clearly indicate the Project Name; Project Number; Date; "To:"; "From:"; names of subcontractors, suppliers or manufacturers; required Specification references; category and type of submittal; purpose; description; distribution record (for transmittals and submittals); and signature of transmitter.

5.4.1.3 Checking of Submittals

Examine and check the submittal for accuracy, completeness, and compliance with the Contract before delivery to Torrance Transit Systems. Stamp and sign each submittal with the statement reading as follows: "Having checked this submission, we certify that it conforms to the requirements of the Contract in all respects, except as otherwise indicated". By reviewing, approving, and submitting a submittal, the Contractor has determined and verified materials, field measurements, and field construction criteria related thereto, and has checked and coordinated the information contained within such submittals with the requirements of the Work and the Contract.

5.4.1.4 Record of Submittals

Maintain at the worksite a complete up-to-date, organized file of all past and current submittals including an index and locating system, which identifies the status of each submission.

- Assign sequential numbers to each submittal.
- Assign revisions levels (A, B, C, etc.) to all resubmittals. Assign new transmittal numbers and cross references to previous submittals.

5.4.1.5 Electronic Format

All submittals shall be provided in electronic format as well as hardcopy. File formats for electronic copies shall be subject to Torrance Transit Systems approval. Current version, industry-prevalent software shall be utilized for preparing all submittals. Drawings shall be submitted in AutoCAD 2007. Drawings or studies involving geographic information shall be submitted in a format that can be viewed by ESRI ArcView software. The Contractor shall furnish to Torrance Transit Systems three fully licensed copies of all software necessary for viewing and marking up the submittals version, industry-prevalent software shall be utilized for preparing all submittals.

5.4.2 Torrance Transit Systems Review

Torrance Transit Systems and/or designated representative will review and approve or take other appropriate action upon the Contractor's submittals. Torrance Transit Systems' action will be taken as to cause no delay in the Work or in the activities of the Contractor. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of Equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract. Torrance Transit Systems' or designated representative's review will not constitute approval of safety precautions or, unless specifically stated by Torrance Transit Systems or designated representative of any construction means, methods, techniques, sequences, or procedures. Torrance Transit Systems' or designated representative's approval of a specific item does not indicate approval of an entire assembly of which the item is a component.

5.4.2.1 Torrance Transit Systems Acknowledgement and Disposition

All Contractor's submittals will be acknowledged by Torrance Transit Systems or designated representative with (a) the date of receipt, and (b) one of the following dispositions (will be sent to the Contractor. (Transmit submittals will not be returned).

1. APPROVED: Work may proceed, provided it complies with the Contract. The approval of documents, shop drawings and samples shall not be construed as;

- Permitting any departure from the Contract requirements;
- Relieving the Contractor of responsibility for errors and omissions, including details, dimensions, and quantity of materials; or
- Approving departures from details furnished by the Contracting Officer or designated representative.

2. APPROVED AS NOTED (Correct and resubmit): Work may proceed, provided:

- It complies with the Contract as well as the corrections on the submittals, and the Contractor resubmits within fifteen (15) days corrected copies of the shop drawings, working drawings, or miscellaneous submittals for final approval; and
- Work performed by the Contractor prior to receiving final approval will be at the Contractor's risk.

DISAPPROVED (Revise and Resubmit): Work is not recognized as being able to proceed. Revise submittal in accordance with notations thereon, and resubmit without delay. The Contractor shall handle re-submittals in the same manner as first submittals, except designated with suffix A, B, C, etc. to indicate 1st, 2nd, or 3rd resubmittals. On resubmittals, direct specific attention in writing on resubmitted documents, shop drawings, working drawings, samples, mock-ups, sample panels, or miscellaneous submittals to revisions other than the corrections required on previous submissions. Make corrections as required by Torrance Transit Systems or designated representative.

5.4.2.2 Actions Following Review

APPROVED documents and drawings will be identified as having received such approval with a dated acknowledgement. DISAPPROVED documents and drawings will be returned to the Contractor with a dated acknowledgement and directions for correction and re-submittal.

5.4.3 Drawings

5.4.3.1 Quality of Drawings

The Contractor shall be responsible for accuracy and correctness of all drawings. The Contractor's Project Manager and STSM shall initial each drawing after checking it, indicating that it complies with all requirements of this Specification and accurately reflects intended or actual field conditions. Drawings that require a Professional Engineer's seal per California State Law shall be sealed and signed by the Contractor's Professional Engineer before submittal.

The Contractor shall check each drawing for the following:

- Conformance with Contract Documents
- Logical grouping and arrangement
- Accuracy
- Legibility
- Neatness
- Line Quality
- Lettering Quality
- Reproduction Quality
- Completeness

5.4.3.2 Content of Drawings

The Contractor shall prepare such design, working and shop drawings as are necessary to adequately perform the Work. Each drawing shall be laid out in an organized manner such that it is easily understandable. The use of crossed lines in schematic or functional drawings shall be avoided, to the extent possible. Breaks and continuations in drawings shall be minimized. Mounting and installation drawings shall be accurately scaled and the scale shall be clearly noted on the drawing. All symbols and abbreviations used shall be defined on each drawing, or if submitted as a book of drawings, on a master symbol sheet.

5.4.4 Product Data Submittals

5.4.4.1 Quality of Submittals

A submittal shall be prepared for each major piece of material or equipment that the Contractor intends to furnish. These submittals shall be known as "Product Submittals". Four copies of each product submittal shall be furnished. Each submittal shall be accompanied by a cover letter with reference number, signed by the Project Manager. Each submittal shall contain a list of any parameters for which the submitted products do not meet the Specifications and a description of how these changes will affect system design. Each submittal shall contain a description of any changes in design or products that the submitted products will cause.

5.4.4.2 Content

Each submittal shall contain sufficient information to determine that the system component complies with the Specifications and Agreement. Actual values of all specified parameters shall be listed; a simple statement that the product complies will not be sufficient. Each product submittal shall be accompanied by engineering drawings necessary to determine the product's applicability to TOM design. All closely related products shall be submitted as a single package. When pre-printed material is used in a submittal, the specific model number and options to be furnished shall be clearly identified. Standard data sheets can be used, subject to the following:

- Manufacturer's standard and/or schematic drawings are modified to delete information, which is not applicable to the Contract. The Contractor shall supplement standard information with additional information applicable to this Contract.
- Manufacturer's standards, diagrams, schedules, performance charts, illustrations, calculations, and other descriptive data are modified to delete information, which is not applicable to the Contract. The Contractor shall indicate dimensions, clearances, performance characteristics, capacities, and any other diagrams, as applicable.
- Installation, erection, application, and placing instructions shall be modified to delete information which is not applicable to the Contract.

5.4.5 Test Procedures

The Contractor shall submit three copies of each test procedure description <CDRL> for approval by TTS, accompanied by a cover letter with reference number.

5.4.5.1 Submittal Organization

Each test procedure description shall include the following information:

- A statement of the purpose of the tests
- The location, date(s) and time(s) tests will be performed
- Staff required to perform the test
- The quantity of units to be tested

- The test equipment to be used, identified by manufacturer and model number
- A step by step description of the procedure to be performed
- Specific pass/fail criteria for each test
- A sample of the form(s) to be used to record test data.

Each test form shall include the following information:

- Test title
- The manufacturer, model number and calibration date of each piece of test equipment.
- A table to record individual readings taken and inspections performed for each unit tested, identified by the serial number of the unit tested.
- An indication that the unit has passed or failed each individual test.
- A line for signature of the technician performing the test and date.
- A line for signature of the Project Manager and date.
- A line for signature of Torrance Transit Systems representative witnessing the test.
- Drawings illustrating the configuration of the equipment tested and all test equipment utilized.

5.4.6 Test Results

5.4.6.1 Content

One original, two copies, and electronic copy of the test results shall be submitted <CDRL>. The original of the test results shall contain the original test forms filled out by the technicians performing the tests and original signatures. The test forms shall be filled out in ink and no erasures shall be made. Errors shall be crossed out with a single line and initialed by the person making the correction. Each set of test results shall be accompanied by a cover letter with reference number.

5.4.6.2 Organization

Each set of test results shall include the following information:

- The complete test procedures used.
- The completed, signed test forms.
- A summary of the test, indicating quantity tested, quantity that failed, quantities that failed each individual procedure, and a statement of the remedy to be applied for failed units.

5.5 AS-BUILT DOCUMENTATION

As-built documentation shall include drawings and software documentation. As-built documentation shall include:

- Design and Installation Plans of the Onboard TOM subsystems for each bus and vehicle type
- Design and Installation Plans of the Yard subsystem
- Design and Installation Plans of the TOM Computer subsystem
- Design and Installation Plans of the TOM LAN and WAN, if applicable
- Design and Installation Plans of the Computer Aided Dispatch subsystem
- Design and Installation Plans of the fixed radio subsystem
- Design and Installation Plans of the Road Supervisor subsystem
- Design and Installation Plans of the Traveler Information subsystem

5.5.1 As-Built Drawings

5.5.1.1 Drawings Content

As-built drawings shall provide a permanent record of the finished system. Each design, working and shop drawing that was submitted for approval shall be modified to reflect the actual installed condition and shall become an as-built drawing. These drawings shall be supplemented with site specific information. If a drawing is typical for more than one location, the locations shall be explicitly listed on the drawing:

- All nomenclature and labels shall correspond to the actual labels on the installed Equipment.
- Each connection to each piece of equipment, junction box, or terminal block shall be identified by function and color code.
- All dimensions, physical details, connections, and other information pertinent to system diagnostics, maintenance or troubleshooting shall be shown.

5.5.1.2 Organization of Drawings

All drawings germane to a subject shall be submitted as a package with a cover sheet, index, and symbols and abbreviations table. A master index of as-built drawings that organizes the drawings by package and drawing number shall be provided.

5.5.1.3 Submittal of Drawings

A pre-final version of the as-built drawings shall be submitted to Torrance Transit Systems prior to maintenance training and prior to acceptance testing <CDRL>. The Contractor shall correct any inaccuracies and add plans to correct any deficiencies as identified by Torrance Transit Systems or as necessary to document changes made during acceptance testing. Final versions of the as-built drawings shall be submitted within two weeks after acceptance testing or maintenance training, whichever is later <CDRL>.

5.5.1.4 Products

Two copies of pre-final drawing packages shall be submitted in 11”x17” hardcopy format and two copies on CD-ROM in AutoCAD 2007 or later format or DXF format. Three copies

of final as-built drawings shall be submitted in 11”x17” hardcopy format and two copies on CD-ROM in AutoCAD 2007 or later format or DXF format.

5.5.2 As Built Software Documentation

The Contractor shall provide all "Computer Software" and "Data" to allow Torrance Transit Systems to fully maintain and update all "Applications Software". "Computer Software" and "Data" shall include as-built versions of <CDRL>:

- Software Requirements Specification;
- Software Version Description Document, or equivalent;
- All "batch" or equivalent files, and all object libraries and "include" files, for editing, compiling, linking, and installing application software. Corresponding instructions shall also be provided;
- All files required to define, allocate, and load the database, and any other data files required to define, configure, load, or operate the system. Corresponding instructions shall also be provided.
- A list of the configuration parameters and their values. A list of potential problems if the configuration parameters are set to extreme values.

Two copies of each document shall be submitted in electronic form (Diskette, CD-ROM, or other media and in a format that is accessible by Torrance Transit Systems) in order for it to be incorporated into Torrance Transit Systems’ Electronic Document Library.

The Contractor shall be required to provide source code and sufficient documentation including source code documentation in Escrow to permit modification of the delivered software without the necessity of contacting the Contractor in the event the Contractor is unwilling or unable to undertake such modifications. Proposers shall explain, in detail, the documentation to be supplied, provide samples, and guarantee of content with proposals. Source code and source code documentation for COTS software shall not be required.

5.6 PROJECT CLOSEOUT

Project closeout shall include an initial survey and a final survey.

5.6.1 Initial Survey

5.6.1.1 Pre-Requisites

Prior to requesting an initial closeout survey of TOM, the Contractor shall ensure the following conditions shall have been met <CDRL>:

- The systems acceptance test has been conducted.
- The Contractor has listed those items yet to be completed or corrected and has submitted a detailed plan of action and schedule for completion of the outstanding items.
- The Contractor has submitted special guarantees, warranties, maintenance agreements, final certifications and similar documents.
- The Contractor has obtained and submitted operating certificates, if required, final inspection and test certificates, and similar releases enabling full and unrestricted use of the Work.
- The Contractor has submitted operations and maintenance manuals and final as-built documentation.
- The Contractor has delivered tools, including special tools, test equipment, standby equipment, and similar items.

5.6.1.2 Conducting the Survey

Upon receipt of the request for initial survey, Torrance Transit Systems will prepare a list of any additional work items that are outstanding. Torrance Transit Systems will schedule a time for Torrance Transit Systems and the Contractor to inspect the Work and prepare a list of exceptions, if any.

5.6.2 Final Survey

5.6.2.1 Pre-Requisites

The Contractor shall perform the Work necessary to complete and correct the items noted during the initial survey. The Contractor shall provide written notice to Torrance Transit Systems that the items have been completed <CDRL> and TOM is ready for final survey.

5.6.2.2 Conducting the Survey

Upon receipt of the notice, Torrance Transit Systems will schedule a final survey to verify that all of the Work items have been completed satisfactorily.

5.7 SYSTEM DELIVERABLES

TOM deliverables provided by the Contractor shall include all Work required to deliver the System and System Components in accordance with this Specification and Agreement. This list is for convenience of the bidders only and shall not be considered to be all-inclusive. All hardware delivered shall have a full life span when delivered to Torrance Transit Systems. All hardware and software shall be the newest version available at the time of installation at Torrance Transit Systems.

5.7.1 Bus Subsystem

The Contractor shall provide 63 Onboard TOM subsystems that shall be installed in buses and successfully pass acceptance tests. Each Onboard TOM subsystem shall include a voice mobile radio, data mobile radio or cellular data modem, wireless LAN radio, GPS receiver, onboard processor, MDT, VHM, video system interface, headsign interface, PA interface, APC (option), and AVA (option).

The installation of the Onboard TOM Systems shall be accomplished per the Contractor provided and Torrance Transit Systems approved schedule.

5.7.2 Spares

The Contractor shall deliver spares as specified in Section 8.

5.7.3 TOM CAD Computers

The TOM CAD computers (servers and LAN) shall be delivered and installed in the TTS computer room as designated by Torrance Transit Systems. The installation shall be accomplished per the Contractor-provided and Torrance Transit Systems-approved schedule. Installation of CAD hardware shall not disrupt City or TTSoperations.

5.7.4 TOM Dispatch Center Consoles Subsystem

The Contractor shall deliver the TOM Dispatch Center consoles subsystem that includes two dispatch consoles, two management monitoring console (option), one AVA editor workstation (option), and one logging recorder at the TTS facility. The TOM Dispatch Center consoles subsystems shall be delivered and installed at locations in the TTS facility as designated by Torrance Transit Systems. The installation of the Dispatch Center and management monitoring consoles shall be accomplished per the Contractor-provided and Torrance Transit Systems-approved schedule.

5.7.5 Yard Subsystem

The Yard Subsystem shall include WLAN Access Points and a server/workstation. The Yard Subsystem shall be delivered and installed at locations at the TTS facility as designated by Torrance Transit Systems. The installation of the Yard Subsystem shall be accomplished per the Contractor-provided and Torrance Transit Systems-approved schedule.

5.7.6 Radio Subsystem

The Contractor shall deliver and install a voice radio interface and either a data radio or cellular data system.

If a data radio system is implemented, the data radio subsystem shall include one basestation, antenna, and 24V backup batteries. The Contractor shall perform all tasks necessary to interface the dispatch consoles to the voice and data radio systems.

The Contractor shall deliver and install the radio subsystem at the site(s) proposed by the Contractor. The Contractor shall perform all tasks necessary to prepare and modify sites for the installation.

The installation of the radio subsystem shall be accomplished per the Contractor-provided and TTS-approved schedule.

5.7.7 Supervisor Subsystems (Option)

The Contractor shall deliver and install 5 Supervisor Systems in supervisor vehicles and maintenance truck as designated by TTS with a voice radio, data modem, MDT, Onboard Processor with spread spectrum radio, and GPS receiver.

The installation of the Supervisor Systems shall be accomplished per the Contractor-provided and Torrance Transit Systems-approved schedule.

5.7.8 Road Supervisor Subsystems (Option)

The Contractor shall deliver and install 4 Road Supervisor Subsystems in supervisor vehicles designated by TTS with a voice radio, MDC with cellular data modem, spread spectrum radio, and GPS receiver.

The installation of the Road Supervisor Systems shall be accomplished per the Contractor-provided and Torrance Transit Systems-approved schedule.

5.7.9 Traveler Information Subsystem

The installation of the Traveler Information Subsystem shall be accomplished per the Contractor-provided and Torrance Transit Systems-approved schedule.

As an option, the Contractor shall deliver and perform all tasks necessary to install 3 electronic display signs and 1 monitor. The monitor shall be at least a 40 inch LCD.

As an option, the Contractor shall deliver and perform all tasks necessary to implement an IVR system.

5.7.10 TOM Software and Database

The Contractor shall deliver and install all software and databases used on TOM, including the TDB. The installation of the TOM software databases shall be accomplished per the Contractor-provided and Torrance Transit Systems-approved schedule. Installation and testing of software and databases shall not disrupt Torrance Transit Systems bus operations.

5.7.11 Diagnostic and Test Equipment

The Contractor shall provide all necessary equipment for diagnostic testing of the Onboard TOM subsystem, Computer Aided Dispatch subsystem, and Radio subsystem.

Contractor shall provide one Mobile Test set, one mobile programming laptop, and one fixed radio programming laptop (option).

5.7.12 Manuals, Training, and Training Tools

The Contractor shall provide manuals, training, and training tools including a "Bus in a Box" and other simulators and training/testing units for the proper operation, maintenance, and repair of TOM. Delivery of the manuals, training, and training tools shall be accomplished per the Contractor-provided and Torrance Transit Systems-approved schedule. The "Bus in a Box" shall contain a voice radio and handset, data radio and modem or cellular data modem, Onboard processor, and MDT. One "Bus in a Box" simulator shall be furnished.

5.7.13 Design Submittals

The Contractor shall provide preliminary and final design submittal packages, as well as individual design details for all elements specified herein. The Contractor shall provide detailed cut-over plans and procedures. All submittals shall be in both hardcopy and electronic format.

5.7.14 As Built Documentation

The Contractor shall provide As Built Documentation as described in Section 5.5.2. Delivery of the As Built Documentation shall be accomplished per the Contractor-provided and

Torrance Transit Systems-approved schedule. All as-built documentation shall be provided in both hardcopy and in electronic format.

5.7.15 Monthly Status Reports

Monthly status reports shall be submitted to Torrance Transit Systems on the 10th of each month detailing the previous month's progress <CDRL>. The monthly status report shall contain a description of the activities and accomplishments, an updated schedule showing the progress, and any issues or concerns. Contractor format is acceptable.

5.7.16 Test Plans/Procedures and Test Results

The Contractor shall provide all Test Plans/Procedures required for the TOM project and the Test Results. The Test Plans/Procedures and Test Results format shall be submitted to Torrance Transit Systems for approval.

5.7.17 Closeout Documentation

The Contractor shall provide closeout documentation as described in Section 5.6.

5.8 SYSTEM SUPPORT

5.8.1 Prior to System Acceptance

Support for the maintenance and operation of installed TOM subsystems shall be provided after incremental acceptance and prior to System Acceptance. It is Torrance Transit Systems' intent to begin operating TOM after completion of the first incremental acceptance. Between the first incremental acceptance and the System acceptance the Contractor shall provide support to Torrance Transit Systems to repair TOM equipment and assist with data management and report generation.

- Support shall be provided on-site at Torrance Transit Systems during testing and cut-over of TOM equipment on a continuous basis.
- Support for in-service TOM equipment shall be provided twenty-four hours per day, seven days per week. All requests by Torrance Transit Systems for assistance shall be answered within thirty minutes of a page or message from Torrance Transit Systems. On-site support shall be provided within two hours at the Torrance Transit Systems facility.

5.8.2 Post System Acceptance

The Contractor shall provide on-call and on-site support during the warranty period as defined in the Warranty provision of the Contract. Defective equipment shall be repaired and

returned to TTS within 10 days. On a quarterly basis, the Contractor shall provide a list of security patches for the operating systems that can be installed by Torrance Transit Systems.

The Contractor shall provide to Torrance Transit Systems a full warranty for on-site maintenance/operation support and software maintenance/ upgrades for five years after System Acceptance. Torrance Transit Systems intends to support TOM with TTS personnel, but may require additional support at times. The additional support shall be mainly telephone support but may require occasional on-site support.

5.9 QUALITY ASSURANCE

The Contractor shall submit to Torrance Transit Systems within 60 days of the Notice-To-Proceed (NTP) a comprehensive Quality Assurance (QA) Program Plan designed to ensure the quality of all activities, including design, purchasing, inspection, handling, assembly, fabrication, testing, storage, shipping, and warranty/repair work <CDRL>. The plan shall describe all quality control procedures of the Contractor and any sub-suppliers. The Contractor shall conduct regular inspections in accordance with guidelines defined by the QA Program Plan. Performance of any manufacturing or construction work shall not commence until the Quality Assurance and Control Plan relating to such Work has been accepted by Torrance Transit Systems. The Contractor shall update the QA Program Plan as necessary, when any deficiencies in the Work are discovered.

Torrance Transit Systems will, at its own discretion, perform QA monitoring of work done under this Contract, including monitoring of the Contractor's or Subcontractor's QA activities. Upon request, the Contractor's QA records shall be made available to Torrance Transit Systems for inspection. Such QA activities performed (or not performed) by Torrance Transit Systems shall not reduce nor alter the Contractor's QA responsibilities or its obligation to meet the requirements of this document.

At any time during the manufacturing process, Torrance Transit Systems may choose to visit the Contractor's facility or a Subcontractor's facility during normal working hours to audit the manufacturing and quality control processes.

5.9.1 Technical Documents

A key component of the TOM implementation is the accuracy and value of all deliverables. The technical documents prepared by the Contractor during the course of this project will include design reports, installation drawings, test plans, test reports, progress reports, and other technical memos. A review process shall be established by the Contractor to assure all System Components are checked for accuracy, correctness, uniformity, and compliance with standards of practice.

The various tiers of the review cycle are detailed as follows:

- The Contractor's Project Manager shall review project products for adherence to the standards of care common to the profession.
- The Contractor's Project Manager shall be responsible for assigning qualified professionals to check all work products for accuracy, uniformity, and clarity. Responsibility for interface, control, and integration of disciplines into a uniform and coordinated document set is also included in this role.
- The Senior Technical Staff Member and individuals assigned as technical discipline leaders within the Contractor team shall provide another review. The reviews shall be initiated by the Project Manager and shall focus on a technical discipline review of selected project products.
- Torrance Transit Systems will provide a final review. This review will occur only after the Contractor's internal review cycles have been completed.

When review comments result in a change to any technical document, the Contractor's Project Manager shall be responsible for change coordination and document back-check. In addition to the formal and on-going quality control review, timely coordination meetings with all project staff shall be held to provide for interdisciplinary liaison and interface coordination. These meetings shall be utilized to schedule work assignments, identify and resolve coordination issues, and track progress associated with any problems encountered and their resolution.

5.9.1.1 Document Management

Due to the substantial amount of documentation involved in this project, Contractor shall work with Torrance Transit Systems' Project Manager to develop and submit to Torrance Transit Systems a Documentation Management System <CDRL>. The Document Management System shall include an organized electronic library of all versions of all submittals and a log of the contents. This shall be completed within 30 days after Notice to Proceed.

TTS and the Contractor shall mutually agree on a documentation file index that shall provide an overall methodology for referencing documents generated in the course of the project. File type and organization of electronic versions of documentation shall be mutually agreed on by Torrance Transit Systems and Contractor. All subsequent documentation shall be referenced to the file index, and Contractor and Torrance Transit Systems shall mutually maintain the file index in current condition so as to show all documents that have been generated and their status.

Documentation in the DMS shall be readily available to Torrance Transit Systems' Project Manager, designated personnel within the Contractor's organization, TOM Consultant, and additional Torrance Transit Systems-designated personnel. Security methods shall be available to restrict access by others.

5.9.2 System Components

The Contractor shall conduct regular inspections and audits in accordance with guidelines defined by the QA Program Plan. The Contractor's Project Manager shall establish a quality

assurance process and be responsible for assigning qualified professionals to check all System Components for compliance with the TOM specifications and consistency in production quality. This quality assurance program shall supplement the formal testing requirements as per Section 9 to verify that:

- Prior to installation, all System Components delivered by the Contractor shall pass rigorous screening that complies with standards of practice.
- All delivered System Components shall be tested after installation. Testing shall include hardware and software interface tests.

5.9.3 Manufactured Products

The Contractor shall utilize products manufactured by companies that utilize formal, documented quality assurance practices that meet or exceed the standard of care established by the industry. The Contractor shall proactively monitor each supplier's quality system. Quality systems that conform to ISO 9000 practices are preferred.

6 MANUALS

This section identifies the manuals to be provided to support training and give on-going documentation needed for Torrance Transit Systems staff to manage, operate, maintain, and expand the TOM.

6.1 MANUAL USERS

The Contractor shall provide manuals to at least Torrance Transit Systems staff listed in Table 6-1, below <CDRL>:

Table 6-1

Manuals for	Number of hardcopies
Bus operators	110
Transit Supervisors	10
Dispatch Center Lead Bus Operators	10
Yard Subsystem User	10
Onboard communication equipment technicians	10
Fixed communications technicians	5
Onboard equipment maintenance technicians	12
APC operations analysts (option)	5
Workstation maintenance technicians	5
Computer system administrators	5
Data administrators	5

6.2 GENERAL REQUIREMENTS FOR MANUALS

6.2.1 Development Process

The Contractor shall prepare a complete plan for providing the manuals described herein. The plan shall include at least the following:

- Contractor shall submit for approval the outline of each manual as a part of the Preliminary Design Review <CDRL>.
- Contractor shall develop and submit a draft version of each manual submitted with the Final Design Review <CDRL>.
- Contractor shall deliver one complete set of manuals prior to the start of the acceptance testing <CDRL>.
- Contractor shall incorporate information gathered during installation and acceptance testing, throughout the maintenance and warranty period into the manuals for the updated and final submittals <CDRL>.

6.2.2 Content

Manuals shall contain all of the informational material required to support the area of activity and include all information to be covered for the associated user training classes.

6.2.2.1 All Manuals

All manuals shall conform to the following:

- Be in concise form, with minimal redundancy.
- Be organized in clear, logical fashion, and indexed and tabbed for rapid access.
- Be in English.
- Be written for comprehension by persons with a high school education.
- Contain table of definitions for all abbreviations, acronyms, and special terms.

6.2.2.2 All Operations Manuals

All operations manuals shall contain the following:

- Instructions on navigation from one function to another.
- The meaning of all display symbols and labels.
- The meaning and interpretation of all alarms and messages, and the recommended remedial action for each alarm and message.
- A reference card defining each cursor command, control key, and status indication.

6.2.2.3 All Equipment Maintenance Manuals

All equipment maintenance manuals shall contain:

- A section on safety procedures and precautions necessary to prevent damage to equipment, injury to personnel, and unsafe operational conditions.
- A section with an overview of the test equipment and tools necessary to troubleshoot and maintain TOM.
- Wiring diagrams and physical layout drawings for all equipment
- A section addressing the intervals and procedures for all preventive maintenance including level adjustments and cleaning.

6.2.3 Medium and Formats for Delivery

6.2.3.1 Hardcopy

The Contractor shall deliver to Torrance Transit Systems the quantities of manuals specified in Table 6-1 in hardcopy form, with appropriate binding and labeling.

- Manuals shall be designed for continuous, long-term service in a maintenance shop or vehicle environment.

- Manuals shall lie flat when opened.
- Pages shall be printed on both sides.
- Manuals shall permit adding and replacing pages.
- Covers shall be oil, water, and wear resistant.

6.2.3.2 Softcopy

In addition, the Contractor shall deliver to Torrance Transit Systems electronic copies of all manuals and their components that are developed by the Contractor, or by vendors in response to the requirements of this Contract.

- The electronic form shall consist of two copies of each final manual on an electronic storage medium (CD-ROM or other approved media).
- The format of the storage medium shall be one that is widely used and easily available to Torrance Transit Systems.
- The manuals shall be stored as MS Word, Portable Document File, or other Torrance Transit Systems-approved format.

6.3 BUS OPERATORS MANUAL

The Contractor shall provide a manual for bus operators. The manual shall provide a clear and concise description of operator interface with TOM and related Torrance Transit Systems operating policies and procedures. At a minimum, the manual shall include the following topics:

- Overview of the TOM System
- Onboard subsystem description
- How the bus operators are to perform all communications and bus fleet management functions provided at the bus Mobile Data Terminal.
- Procedures for radio calls.
- Procedures for sending canned messages, and receiving and responding to text messages
- Procedures for SAS
- Procedures for logon/logoff
- Help guide for functional failures and problems: Description of the most common failures and explanation of error codes and error messages
- Reference card that is pocket size when folded.

6.4 TRANSIT SUPERVISOR MANUAL

The Contractor shall provide a manual for transit supervisors. The manual shall provide a clear and concise description of supervisor interface with TOM and related Torrance Transit Systems operating policies and procedures. At a minimum, the manual shall include the following topics:

- Overview of the TOM System
- Onboard subsystem overview
- Road Supervisor subsystem description
- Procedures for radio calls using mobile and portable radios
- Procedures for sending and receiving text messages
- How the transit supervisors are to perform all communications, bus fleet management, and dispatching functions provided by the MDC and/or MDT
- Help guide for functional failures and problems
- Description of the most common failures
- Explanation of error codes and error messages

6.5 DISPATCH CENTER LEAD BUS OPERATOR MANUAL

The Contractor shall provide a manual for lead bus operators, transit supervisors, Senior Business Manager, and Transit Operations Manager that are performing dispatch duties. The manual shall provide a clear and concise description of the TOM operator interface for all console functions provided, including normal call, messaging, and schedule and route adherence functions. At a minimum, the manual shall include the following topics:

- TOM overview
- Onboard subsystem overview
- CAD subsystem description
- Road Supervisor subsystem overview
- How the lead bus operators, transit supervisors, and Senior Business Manager, and Transit Operations Manager are to perform all communications and bus fleet management functions provided at the dispatcher consoles.
- How the Senior Business Manager and Transit Operations Manager can assign work assignments.
- How to manage work assignments, the work queue, and incident reports at their various stages.
- How to perform rudimentary remedial action for limited-scope failures, including: shutting down and restarting console processors, shutting down and restarting console-based software processes, and restarting printer queues.
- Description of the most common failures
- Explanation of error codes and error messages

6.6 YARD SUBSYSTEM USER MANUAL

The Contractor shall provide a manual for users of the Yard subsystem. The manual shall provide a clear and concise description of all console functions provided by the Yard workstation. At a minimum, the manual shall include the following topics:

- TOM Overview
- Yard subsystem description
- Onboard subsystem overview

- How the Yard subsystem functions are accessed
- How the Yard subsystem users are to perform the communications and fleet management functions provided by the Yard Subsystem workstations.
- How to manage data uploads and downloads via the wireless LAN
- Description of the most common failures
- Explanation of error codes and error messages
- How to perform rudimentary remedial action for limited-scope failures, including: shutting down and restarting console processors, shutting down and restarting console-based software processes, restarting printers, and restarting printer queues.

6.7 ONBOARD COMMUNICATIONS MAINTENANCE MANUAL

The manual shall provide a logical structure and organization for the maintenance manuals provided by the manufacturers of the radio and/or cellular equipment for the Onboard subsystem, and shall provide any necessary information to supplement them to fulfill the requirements of this section. At a minimum, the manual shall include the following topics:

- TOM Overview
- Onboard TOM subsystem description
- Voice radio and wireless data communication subsystem description
- Description of the most common failures
- Explanation of error codes and error messages
- How to identify the source of a problem to a specific replaceable element
- Provide a logical procedure for isolation of a problem
- How to replace an element. Provide a detailed procedure or a reference to a manufacturer manual detailed procedure for removal and replacement of each onboard subsystem element. This shall include setting and verification of options and programming.
- Testing of the replaced unit and associated equipment to verify correct operation of the repaired onboard subsystem

6.8 FIXED COMMUNICATIONS MAINTENANCE MANUAL (OPTION)

The fixed communications and radio subsystem maintenance manual shall complement the maintenance training provided and shall supplement the maintenance manuals provided by the manufacturers of the fixed radio subsystem equipment to fulfill the requirements of this section. At a minimum, the manual shall include the following topics:

- TOM Overview
- Voice radio and wireless data communication subsystem functional description
- Description of the most common failures
- System diagnostic procedures

- Explanation of error codes and error messages
- Logical procedures for isolating a problem to a specific replaceable element
- How to replace an element: A detailed procedure or reference to a manufacturer manual detailed procedure, for removal and replacement of each fixed radio subsystem element
- Verification of correct operation of the repaired voice and wireless data communication subsystem: Instructions for setting and verification of options, programming, and testing of the replaced unit and associated equipment to verify correct operation
- Description of self-diagnostic features and system administrator reports

6.9 ONBOARD EQUIPMENT MAINTENANCE MANUAL

The manual shall focus on guiding technicians in verifying the presence of a failure and performing first echelon replacements. At a minimum, the manual shall include the following topics:

- TOM Overview
- Functional description of the Onboard Subsystem
- Description of the most common failures
- Identification of the source of a problem to a specific replaceable element, provide a logical procedures for isolating a problem. Provide a description of self-diagnostic features
- Explanation of error codes and error messages.
- Calibration of the APC sensors. (option)
- How to replace an element: Detailed procedure or reference to a manufacturer manual detailed procedure for the removal and replacement, and verification of first echelon replaceable elements. This shall include the setting and verification of options and programming.
- Verification of correct operation of the repaired onboard subsystem. Include instructions for setting and verification of options, programming, and testing of the replaced unit and associated equipment to verify correct operation.

6.10 APC OPERATIONS ANALYST MANUAL (OPTION)

The Contractor shall provide a manual for handling and analyzing APC data. At a minimum, the manual shall include the following topics:

- TOM Overview
- Description of the onboard APC equipment, data capture methods, data anomalies and their detection, data flow, data management processes, database organization, and data dictionary.
- Description of system parameters, how they are applied and at what level.
- Instructions on database maintenance, correction of data anomalies using data management tools, and the generation of APC reports (option) and NTD reports

- Troubleshooting procedures for the correlation processes and processes that add information to the basic APC data. (option)
- Description of data maintenance and data editing procedures.

6.11 DISPATCH CENTER SUBSYSTEM AND YARD WORKSTATION MAINTENANCE MANUAL

The manual shall focus on guiding technicians in isolating the source of a problem to a specific replaceable element, replacement of the element, and verification of correct operation of the repaired subsystem. At a minimum, the manual shall include the following topics:

- TOM Overview
- CAD subsystem functional description
- Yard subsystem functional description
- Dispatch workstation functional description
- AVA subsystem functional description (option)
- Description of the most common failures
- Explanation of error codes and error messages
- LAN, WLAN, and WAN description
- Isolation of a problem to a specific replaceable element: Provide logical procedures for isolating a problem, description of self-diagnostic features and reports.
- How to replace an element: Detailed procedure or reference to a manufacturer manual detailed procedure for removal and replacement or repair of an element.
- Verification of correct operation of the repaired TOM servers. Workstations, LAN, and Dispatch Center equipment. Include instructions for setting and verification of options, programming, and testing of the repaired unit and associated equipment to verify correct operation.

6.12 COMPUTER SYSTEM ADMINISTRATOR MANUAL

The Contractor shall provide a system administrator's manual that provides a clear, organized description of all of the TOM computers, the tools and procedures for managing their configuration, and for diagnosing their performance and problems. At a minimum, the manual shall contain the following information.

- Configuration and operation of the TOM Computer Subsystem, dispatch consoles, Yard Workstation, Road Supervisor MDCs, and TOM WAN/LAN
- Use of performance measurement and analysis tools
- Reconfiguration of equipment around failures
- System backup
- Failing over to backup servers and devices
- Restoration of equipment and data after failures

- Management of system access, security features, user accounts and passwords, and user privileges
- Installing software updates provided by the Contractor and third-party software suppliers
- Use of software configuration management and administration tools and system test tools
- Overview of the structure, organization, and functionality of the system software, application software, and databases
- A high-level and detailed description of computer configurations and interfacing equipment at the Dispatch Center, bus yard, fixed radio site(s), mobile units, configuration of TOM LAN/WAN logical and physical entities, and connections to the TDB and City of Torrance LAN/WAN
- Description of the interfaces to connected systems (TDB, City of Torrance LAN/WAN, Vehicle Health System (option), Yard subsystem, RIITS, and 511 system.)
- A listing and functional description of software components for each computer.
- Computer startup, interconnected systems communications restart, and shutdown procedures
- Overview and details of procedures and tools for installing and verifying new software and rolling back old software for the Dispatch Center, Computer Subsystem, Yard Subsystem, fixed radio site(s), and Onboard TOM subsystem
- Monitoring, analysis, and optimization of computer/LAN/WAN performance
- List of the most common failures
- Equipment and operating system error messages and diagnostics, with remedial action for each
- Tools and procedures to troubleshoot equipment and software problems on all TOM equipment, including TOM LAN and wireless LAN equipment.
- Interpreting and responding to messages generated by error-monitoring software
- Procedures to manage and diagnose interfaces with connected systems

6.13 DATA ADMINISTRATION MANUAL

The Contractor shall provide a data administrator's manual that provides a clear and organized description of all TOM databases. At a minimum, the manual shall contain the following information:

- Structure, interfaces, and functions of the TOM software and databases
- Database documentation for all real-time and historical databases including the configuration, individual elements (files, records, fields, views, and tables), relationships, and security settings for each TOM database. The documentation shall include, but not be limited to, entity-relationship diagrams (ERD) and a complete listing of the data dictionary for each database. Portions of the databases that were developed, modified, or enhanced specifically for the TOM shall be identified.
- Tools and procedures for managing the database configurations
- Procedures for diagnosing problems and repairing the databases

- Configuration and maintenance of TOM databases including TDB, APC (option) and AVA databases (option)
- Updating the AVL map database by importing revised base maps, routes, bus stops, etc.
- Monitoring, maintaining, archiving, and restoring the TOM database and TDB.
- Maintaining, updating AVA (option) and APC databases (option)
- Updating the webpage (option)
- Creating and loading new messages and/or pull down lists for the webpage (option)Procedures for modifying the Route and Stop databases.
- Procedures for importing updated route and schedule databases
- Distribution of map updates to all map-equipped workstations
- Managing downloads and uploads via the WLAN
- Maintaining and tuning the databases using database management tools
- Maintaining interfaces with existing external systems
- Management of data archives
- Generating, deleting, modifying, and installing new reports including the use of ad hoc queries
- Performing updates to the audio/visual next stop announcements, and the destination signs
- Recording new AVA messages, defining the triggering conditions for each message, and adding, deleting, modifying, and downloading the messages to the vehicles (option)
- Description of linkages to the AVA database and application software (option)
- External interfacing data formats, semantics, and protocols.
- Description of data interfaces, tasking, considerations for timing, priorities, and resource use
- Programming and database maintenance tools used to create the TOM software
- Procedures for building and managing software configuration.
- Identification of error conditions detected within the software, and the messages or indications for those conditions.
- Identification of parameters used to adjust TOM operation.
- Procedures to diagnose TOM software functional or performance problems
- Procedures to identify expansion and upgrade needs
- Procedures to install and test new software
- Reviewing schedule adherence data reports generated by TOM
- Procedures for entering scheduling, operator, and vehicle information needed by TOM for the assignment of buses and operators.

7 TRAINING

This section identifies the training to be provided to transfer to Torrance Transit Systems staff the knowledge and skills needed to enable personnel to utilize, manage, operate, maintain, and expand the TOM.

7.1 COURSES AND TRAINEES

At a minimum, the Contractor shall provide training, training materials, and tools to the Torrance Transit Systems staff listed in Table 7-1.

Table 7-1 Training Classes for TTS

	Informal Training (Days)	Formal Training (Days)	Follow Up Training (Days)	Max Students/ Class	# of Classes
Operator Trainer	1	1	0.5	6	1
Transit Supervisor	0	1	0.5	5	2
Lead Bus Operator (Dispatch)	1	2	1	5	2
Yard Workstation Users	0.5	0.5	0.5	5	2
Onboard Equipement Maintenance	0	2	1	4	2
Communication Equipment Maintenance	0	1	1	4	1
System Admin	0.5	2	2	4	1
Data Admin	0.5	2	2	4	1
APC Training	0	2	1	4	1
Manager Overview	0	0.5	0	4	2

The course for Operator Trainer shall include both training in the subject matter and how to present the training from the Trainer's Guide. The Contractor shall present and then make enhancement to the course as often as necessary to improve the quality and completeness of the course.

In addition to the classroom training, the Contractor shall provide computer-based self-study tools for vehicle operators to refresh themselves on procedures.

7.2 TRAINING PLAN

The Contractor shall submit for Torrance Transit Systems approval, within one hundred eighty (180) days after NTP, a complete plan for providing the training described herein <CDRL>. The training sessions shall be scheduled between the completion of design

and the start of installation. The training plan shall include the following information for each course and class:

- A statement of the goals of the training of each course. Among these goals must be an understanding of trainee's role in Torrance Transit Systems operation, and an understanding of how TOM will contribute to success of their job.
- An overview of delivery methods for the course, including hands-on and group work experience.
- The course objectives for trainees, each of which shall be measurable, shall include the conditions of measurement, and shall state the performance or level of success that must be achieved for each learner.
- A list of Torrance Transit Systems operating policies and procedures that will be integrated into the course.
- An evaluation plan, including criteria for success of the course, based upon the goals and objectives, and evaluation steps and instruments to be employed.
- A style guide for training materials that defines proposed formats (e.g. for pages, paragraphs, lists, flow charts, etc.), fonts and types, general chapter organization, guidelines for including manufacturer materials, guidelines for referencing other materials, and methods for highlighting, presenting illustrations and drawings, and depicting procedures.
- A list of the equipment, tools and test equipment, manuals, and other materials to be used as trainee and trainer aids.
- A list of training site requirements.
- A proposed schedule for each class that is linked to the installation process and constrained by availability of trainees away from regular duties. Training shall be completed before installation of the TOM subsystem is to be used by the trainees. Training shall not take place more than two months before the the TOM system is to be used by the trainess.
- A description of the pre-requisite knowledge for each course. The Contractor may assume each trainee has worked in a similar role to that intended for the trainee.
- A plan for developing or customizing course material.
- Resumes of personnel proposed to be trainers for each class, demonstrating that they are experienced, effective training professionals.

7.3 COURSE GENERAL REQUIREMENTS

The Contractor shall submit two copies plus one electronic copy of a complete description for each course listed in Table 7-1, no later than sixty days prior to the scheduled start of the first class for that course, for Torrance Transit Systems approval <CDRL>.

Courses shall be developed under the guidance of a professional courseware developer. Courses shall incorporate the manufacturer’s standard “Factory Training” as appropriate. In particular for the mobile and fixed radio equipment, training shall incorporate the

manufacturer's factory training program. Training shall include hands-on training using the versions of the hardware and software installed in TOM.

Presentation methods for courses shall conform to the following:

- Be founded on an explicit sequencing strategy based on typical trainee characteristics
- Serve multiple learning styles
- Be heavily hands-on or group-based, particularly for skills development
- Contain tell-show-coach-evaluate sequences for skills
- Contain group and cooperative learning
- Include role play where dealing with human interactions
- Provide for independent reading, with workbook, manuals, or computer workstation
- Provide both in-class and independent learning

Each course description shall contain, as a minimum, the following information:

- A statement of the sequencing strategies used.
- A detailed outline of the training steps to be taken in the course, the course objectives to be met by each step, the learning style addressed, the duration (in minutes) for each training step,
- Copies of the course materials, including trainee readings, workbooks, job aids, lecture note sheets, audio and visual aids, computer-based material, manuals, as-built documentation, and other printed materials to be used during the course.
- Description of all other training aids, materials, tools and equipment.
- Detailed descriptions of the procedures to be performed by trainees during hands-on training or group work.
- Torrance Transit Systems operating policies and procedures that are integrated into the course.

Factory-authorized training shall be provided on all equipment, including configuration and maintenance procedures, on the versions delivered before installation.

The Contractor shall certify whether the trainees of the train-the-trainer courses have or have not achieved a level of technical competence needed to provide training to others.

7.4 COURSE MATERIALS

Course materials—including manuals, workbooks, job aids, lecture note sheets, handouts, situational (case study) and procedural audio and visual aids—shall be of high quality. Course materials shall accurately reflect equipment configuration and operation.

The organization and content of course materials shall be directed clearly to course objectives. There shall be no extraneous material. Material shall be organized into the order of presentation (except for reference exhibits). The language used shall be at a

level that is appropriate for the particular training group, with concise statements and well-structured paragraphs. Terms shall be defined. The material shall assume the appropriate prerequisite knowledge.

The course material shall be of uniform appearance and style, across documents (page layout, fonts, pagination) and within each class of material (quizzes, case studies, text, etc.). Page layout shall use high contrast and low density to enhance interest. Key points shall be highlighted. Graphics shall be used that support the content.

The course printed materials shall be assembled for accessibility for in-class and on-job reference, with tabbed sections and content-related labels.

Course supporting devices, including "Bus in a Box", workbench tools, and console or workstation simulators shall match those to be used on the job.

The course test and evaluation instruments shall be included. These shall measure progress against objectives (including attitudinal or affective objectives). They shall also measure the trainees' response to environment, instruction quality, and content quality. Tests for pre-requisite knowledge, post-course, and on-the-job knowledge shall be included. The Contractor shall provide software tools for capturing and summarizing test and evaluation results. The test results shall be reviewed by the Contractor and Torrance Transit Systems and changes shall be made to the course material as as result of this review.

The Contractor shall provide sufficient training materials for each trainee for each course listed in Table 7-1 <CDRL>. The Contractor shall provide special tools and equipment in sufficient quantity to support the schedule of classes in the Training Plan.

Option: The Contractor shall provide independent-study courseware for bus operators and supervisors <CDRL>. This courseware shall be computer-based. The courseware shall include evaluation and reporting features to track progress.

7.5 COURSE CONTENTS

The Contractor shall provide the following courses, as listed in Table 7-1:

7.5.1 Bus Operator Trainer

Bus operator trainers shall have a segment of primarily classroom instruction which includes:

- TOM overview
- Onboard TOM subsystem overview
- Bus and MDT startup and shutdown procedures
- Log in and log out

- Use of the voice radio system and call functions for voice calls
- Operation of the MDT for data messaging
- Operation of security features including SAS monitoring
- Use of scheduling and routing features
- Overview of the AVL system
- Overview of APC equipment (option)
- Overview and operation of AVA equipment (option)
- Overview and operation of VHM (option)
- MDT keypad training

The bus operator trainers shall also have a segment of working through the dispatch system. This shall include classroom instruction on the functions of the dispatch console, hands-on operation of the radio-related functions of the dispatch console, operation of an MDT while observing the answering dispatch console, and responding to a wide range of problem scenarios. The materials and facilities needed include: TOM Bus Operator manuals; procedures and policies manuals; workbooks; pocket size Quick Reference Card; fully functional bus MDTs for the trainees to use; Bus in a Box with interfacing subsystems or emulators for AVL, AVA, APC, VSS, and VHM; and a fully-equipped dispatch console. The AVL emulation shall be controllable through a trainer's workstation to simulate bus motion on specified run, with nominal and off-route/off-schedule conditions.

The Contractor shall develop a Trainer's Guide for this course. The Trainer's Guide shall be designed for use by experienced trainers, rather than subject matter experts in the course topic. The Trainer's Guide shall show trainer and trainee material side-by-side, with the trainer portion containing time needed for each step and clearly described details of how to:

- Present material
- Lead group work
- Run exercises and activities
- Operate special equipment

The Trainer's Guides shall contain supporting material beyond the material for trainees, including:

- An explanation of the instructional and sequencing strategies
- Identification of steps trainees typically have difficulties with, how to recognize those difficulties, and what to do to help
- Suggested questions and answers for discussions
- Evaluation steps that demonstrate knowledge, comprehension, and application
- Appropriate media for each step
- Complete reproducible materials and instructions as appropriate
- Containing checklist of materials and tools

The Contractor shall provide trainee and Trainer's Guide materials in electronic softcopy, in a widely-used format. The Contractor shall grant Torrance Transit Systems all rights to reproduce or modify training materials for its own use as set forth in the Agreement.

7.5.2 Transit Supervisors

Transit supervisors shall receive the same two segments of training as the bus operators. In addition, they shall receive segments of classroom and hands-on instruction on making calls to buses with the portable radio, using the MDT, and dispatching from a Road Supervisor Subsystem MDC. The materials and facilities needed include TOM Transit Supervisor Manuals, procedures manual, workbooks, portable radio, Road Supervisor MDC, and MDTs for the trainees to use that are linked to a fully functional dispatch console and Bus in a Box.

7.5.3 Dispatch Center Lead Bus Operators, Transit Supervisors, Senior Business Manager and Transit Operations Manager

Dispatch Center Lead Bus Operators, Transit Supervisors, Senior Business Manager, and Transit Operations Managers, that perform dispatching duties shall receive a segment of classroom and hands-on instruction for the following:

- Normal and backup radio operation
- Radio call management
- Sending text messages to bus operators and supervisors
- Receiving canned messages from bus operators
- Using the graphical interface to locate and track buses
- Using and changing bus schedules
- Accessing and changing operator, vehicle, line and run assignments dispatcher work assignments and transfers
- Setting and initiating automated announcements
- Interpreting vehicle health data
- Creating and working with incident reports
- Generating standard and custom reports
- Managing SAS and other alarm situations
- Sending text messages to Passenger Information displays
- Use of notification tolerances
- Various soft skills pertinent to working with bus operators and supervisors including effective communications and understanding motivation and culture

In addition, they shall receive the same classroom instruction on Onboard TOM equipment operation provided to bus operators and transit supervisors.

The classroom work shall include responding to a wide range of problem scenarios while working with the dispatch console and observing the interactions with transit supervisors and bus operators using their onboard equipment. The materials and facilities needed include TOM Dispatch Center Lead Bus Operator manuals, procedures manual,

workbooks, and a fully functional dispatch console that is linked to the Bus in a Box and a fully-equipped Road Supervisor System. The training courses shall provide the trainees with basic Windows skills training, if necessary.

7.5.4 Yard Workstation Users

Yard subsystem users shall receive a TOM overview and training on the use of the TOM features available on the Yard workstation including: receiving Road Calls messages, using the graphical interface to locate and track buses, managing WLAN uploads and downloads, modification of operator and bus assignments, interpretation of bus performance and health data, and interpretation of bus status reports. The training shall include hands-on operation of the Yard workstation. The materials and facilities needed include TOM Yard Subsystem Users manuals, procedures manual, workbooks, fully functional Yard workstation that is linked to a fully functional dispatch workstation and the Bus in a Box. The training courses shall provide the trainees with basic Windows skills training, if necessary.

7.5.5 Onboard Equipment Maintenance Staff

Vehicle maintenance staff shall receive a TOM overview and detailed briefing on the Onboard TOM subsystem and its components. They shall receive training on understanding error codes and messages; performing maintenance, diagnostics, calibrations, repairs and replacement of TOM equipment, including Onboard processor, MDT, AVA (option), APC (option) and wireless LAN equipment. Vehicle maintenance staff shall be trained to administer and/or witness acceptance tests for the Onboard TOM subsystem. The materials and facilities needed include a TOM Onboard Equipment Maintenance manuals, procedures manuals, workbooks, Bus in a Box, fully functional installed Onboard TOM subsystem that is linked to a fully functional dispatch workstation.

7.5.6 Fixed and Vehicle Communications Equipment Maintenance Staff (Option)

Torrance communications equipment maintenance staff shall receive training for the maintenance of the voice radio and wireless data communication subsystems, voice radio control stations, dispatch console radio interface, portable and mobile radios, and data modems. The training shall include the concept of operation and hands-on practice in troubleshooting, maintenance, replacement, and repair. The materials needed include: TOM Vehicle Communications Maintenance manuals and Fixed Communications Maintenance manuals, workbooks, and radio and/or cellular equipment manufacturer manuals. The necessary facilities shall include: access to the radio subsystem equipment at the site(s) and TTS facility, and an Onboard TOM subsystem that is installed in a bus.

7.5.7 System Administration Staff

The computer systems and IT staff responsible for the oversight of the TOM Computer subsystem shall receive a training course that includes the following topics:

- Configuration and operation of the TOM Computer subsystem, dispatch consoles, Yard workstation, Road Supervisor MDCs, and TOM WAN, LAN, and wireless LAN.
- Use of performance measurement and analysis tools
- Reconfiguration of equipment around failures
- Troubleshooting
- System backup
- Interpreting and responding to messages generated by error-monitoring software
- Failing over to backup servers and devices
- Restoration of equipment and data after failures
- Management of system access, security features, user accounts and passwords, and user privileges
- Installing software updates provided by the Contractor and third-party software suppliers
- Use of software configuration management and administration tools and system test tools.
- Management and maintenance of the TOM LAN, wireless LAN and associated hardware

The course also shall include an overview of the structure, organization, and functionality of the system software, application software, and database—providing the necessary understanding to allow the system administrator to effectively provide maintenance of the TOM system software. The informal training shall be completed before the installation of TOM deployment. The formal training shall use the final TOM software and associated documentation.

The materials and facilities needed include the Computer System Administrator manuals, Dispatch Center SubSystem and Yard Workstation Maintenance manuals, workbooks, and access to the TOM databases, APC data (option), and TOM workstations.

7.5.8 Data Administration Staff

The computer systems and IT staff that are responsible for the data admin support for TOM shall receive a training course that includes the following topics:

- Structure, interfaces, and functions of the TOM software and databases
- Configuration and maintenance of TOM databases including TDB, website (option), Traveler Information subsystem, APC (option), and AVA (option) databases
- Updating the AVL map database by importing revised base maps, routes, bus stops, etc.
- Distributing map updates to all map-equipped workstations
- Managing downloads and uploads via the WLAN

- Maintaining and tuning the databases using database management tools
- Maintaining interfaces with existing external systems
- Maintaining updated route, bus stop, and schedule data
- Management of data archives
- Generating, deleting, modifying, and installing new reports including the use of ad hoc queries
- Performing updates to the audio/visual next stop announcements and destination sign data (option)
- Recording new AVA messages, defining the triggering conditions for each message, and adding, deleting, modifying, and downloading the messages to the vehicles (option)
- Description of linkages to the AVA database and application software (option)
- Generation and modification of TOM reports
- Creating new messages, pull down items, modifying displays for the website (option)

The course also shall include an overview of the structure, organization, and functionality of the system software, application software, and database—providing the necessary understanding to allow the system administrator to effectively provide maintenance of the TOM system software. The informal training shall be completed before the installation of TOM deployment. The formal training shall use the final TOM software and associated documentation.

Option: The hands-on instruction shall utilize the actual TOM AVA devices, TTS programmable headsigns and the AVA workstation to generate and modify the AVA messages.

Computer software maintenance training shall be given to Torrance Transit Systems staff. The training shall:

- Provide an overview of software organization.
- Define external interfacing data formats, semantics, and protocols.
- Define internal modules, data interfaces, tasking, considerations for timing, priorities, and resource use
- Identify and detail use of programming and database maintenance tools used to create the TOM software
- Detail the procedures for building and managing software configuration.
- Identify the error conditions detected within the software, and the messages or indications for those conditions.
- Identify parameters used to adjust TOM operation.
- Detail procedures to diagnose TOM software functional or performance problems
- Detail procedures to identify expansion and upgrade needs
- Detail procedures to install and test new software

The course shall also include the following topics geared for operations planners, and schedulers:

- Reviewing schedule adherence data reports generated by TOM
- Entering scheduling, operator, and vehicle information needed by TOM for the assignment of buses and operators.

The demonstrations shall use typical data, including typical data inconsistencies.

The materials and facilities needed include Data Administration manuals, workbooks, and access to TOM databases, Yard workstation, and TOM workstations.

7.5.9 APC Operations Analysts (Option)

TTS staff assigned to handling APC data shall receive training on:

- APC data import
- APC database maintenance
- Bus stop data maintenance
- Analysis of the APC data
- Detection and correction of data anomalies using data management tools
- Troubleshooting procedures for the correlation processes and processes that add information to the basic APC data
- Using data management tools
- Generation of NTD and other APC reports
- Database editing procedures.

Materials and facilities needed include APC Operations Analyst Manuals, workbooks, and access to APC data and TOM workstations.

7.5.10 Managers

Managers and TTS staff that deal with public affairs shall receive the following training:

- TOM overview
- A list of the data collected by TOM
- The capabilities and limits of TOM
- How to retrieve information from TOM
- How to share data from the AVL System and Traveler Information System with the public
- The legal requirements fulfilled by TOM
- A review of the standard fleet management reports provided by TOM
- How to create custom queries.

8 SPARES PROVISIONING AND TEST EQUIPMENT

This Section describes the minimum requirements for spare equipment and test equipment for TOM. The Contractor shall work with Torrance Transit Systems to develop recommendations to modify the list provided with the proposal (as per Section 10) as appropriate to support the maintenance of TOM <CDRL>. The Contractor shall provide equipment, in accordance with the approved list, as necessary to achieve the system availability and maintainability as specified herein. The availability of replacement units shall be considered in determining the spare requirements. All spares shall be coordinated with Torrance Transit Systems' staff. Delivery of spares shall be as appropriate to support the initial operation of TOM.

8.1 SPARES

8.1.1 Onboard Subsystem

The Contractor shall furnish spare Onboard TOM subsystems, sufficient to fully equip six TTS buses with all elements on the TTS buses as described in Section 3.8 and 4.6 of this Specification, including all connectors, cables and mounting hardware.

8.1.1.1 Testing

The spare onboard subsystem equipment shall be functionally tested prior to shipment to Torrance Transit Systems, in accordance with the approved factory testing plan and procedure. The test results shall be submitted to Torrance Transit Systems prior to scheduling delivery.

8.1.1.2 Delivery

Torrance Transit Systems shall be notified in writing at least two weeks in advance of each proposed delivery date.

The spare onboard subsystem equipment shall be delivered to Torrance Transit Systems in heavy-duty boxes. The exterior of each box shall be labeled, including manufacturer, equipment type, serial number, and date. The Onboard subsystems shall be delivered to a secure indoor location designated by Torrance Transit Systems. Each shipment shall be accompanied by an inventory list showing the quantities, serial numbers, and brief description of all devices.

8.1.2 Fixed Radio and/or Cellular Equipment

All fixed radio equipment and/or cellular spare equipment shall be delivered to a secure indoor location at the TTS facility that is approved by Torrance Transit Systems.

Equipment shall be delivered in the manufacturer's boxes. An inventory listing showing the quantities and serial numbers of all devices shall be furnished with each delivery.

Option: If a data radio system is implemented, the
Contractor shall supply a spare base station.

8.1.3 Operations Dispatch Center Equipment

It is anticipated that primarily high reliability, COTS hardware shall be utilized. If any hardware is not COTS, spares shall be included in the list provided as per Section 10.

The exterior of each box containing the spares shall be labeled, including manufacturer, equipment type, serial number, and date. An inventory listing showing the serial numbers of all devices shall be furnished with each delivery.

Contractor shall furnish one spare monitoring console processor and monitor, one KVM switch, and any special interface cards, and deliver them in heavy-duty boxes to a secure indoor location at the TTS facility that is approved by TTS.

8.1.4 Wireless LAN Equipment

The Contractor shall furnish one spare wireless LAN Access Point spread spectrum radio of the type implemented in the bus yard and spare special cabling and connectors, as per Section 4 of this Specification.

8.1.5 Traveler Information Display (Option)

If TTS exercises the option to implement electronic displays, the Contractor shall furnish one spare electronic display that meet the requirements in Sections 3.12 and 4.10 of this Specification.

8.1.5.1 Testing

The spare displays shall be functionally tested prior to shipment to Torrance Transit Systems, in accordance with the approved factory testing plan and procedure. Test results shall be submitted to Torrance Transit Systems prior to scheduling delivery.

8.1.5.2 Delivery

Torrance Transit Systems shall be notified in writing at least two weeks in advance of each proposed delivery date.

The spare displays shall be delivered to a secure indoor location at the Torrance Transit Systems facility in heavy-duty boxes. The exterior of each box shall be labeled, including manufacturer, equipment type, serial number, and date.

8.2 TEST EQUIPMENT

8.2.1 Mobile Test Sets

The Contractor shall furnish a complete mobile test set. The mobile test set shall include a fully functioning set of mobile equipment with a power supply mounted on a cart. The Onboard TOM subsystem components shall be mounted on shelves such that each component shall be easily removable so that units under test can be quickly substituted and functional checks performed. All connectors shall be clearly and permanently labeled. The test set shall also be used for training purposes.

8.2.2 Mobile Programming Sets

The Contractor shall provide a ruggedized laptop computer with licensed software, interfaces, and connector cables as necessary for programming and optioning of all mobile equipment for the buses and supervisor vehicles, and for database downloads. The laptop shall use the most current commercial technologies for the processor, RAM and hard drive memory, video and audio cards, DVD and CD-RW, subject to approval by TTS.

The programming and optioning software shall be conveniently organized so that technicians can rapidly and efficiently set up a complete Onboard TOM Subsystem, or any additional component as needed. A step-by-step checklist or wizard-style interface shall be provided to guide technicians through the process. The version and revision of each software component shall be conveniently available in a single table for verification and printing.

8.2.3 Fixed Radio Programming Set (Option)

If a data radio system is implemented, the Contractor shall furnish a laptop computer with software, interfaces, and connector cables as necessary for programming and optioning of all fixed radio equipment, including the base station. The laptop processor, memory, and hard disk capacity shall be as necessary to store and download software, and shall use the most current commercial technologies for the processor, RAM and hard drive memory, video and audio cards, DVD and CD-RW, subject to approval by TTS.
.

9 ACCEPTANCE TESTING

The Contractor shall test each item of equipment provided under this Contract to assure that it is compliant with the Agreement and Specifications, approved design concepts, and is free of manufacturing and/or material defects. For each test, the Contractor shall submit to Torrance Transit Systems evidence in the form of test reports that the equipment has been tested to operate in the stated environment and electrical conditions. This section describes the formal testing requirements. The Contractor shall perform additional testing and pre-testing so that these formal tests can be executed efficiently and effectively, with minimal failures.

The tests shall be conducted in a multi-tiered program intended to identify and correct any deficiencies as early in the program as practical, so that overall impacts to the program development are minimized. In no case shall equipment proceed to the next level of testing or integration without having passed the necessary formal pre-requisite tests.

- Individual System Components shall be tested at the Contractor's factory. Testing at the original equipment manufacturer's factory may be substituted for this testing only, if approved by Torrance Transit Systems based on submitted documentation of the manufacturer's test program and procedures. System Components shall not be assembled into subsystems prior to completion of satisfactory testing of the elements. Requirements for individual System Component testing shall be as stated in this section in general and the Agreement and shall include any additional requirements stated in the individual sections of this Specification.
- An Onboard subsystem demonstration shall be held within five months after a notice-to-proceed is issued to the Contractor. This demonstration shall identify the Contractor's progress in developing the Onboard TOM Subsystem and shall assist in acclimating Torrance Transit Systems personnel to TOM.
- The subsystems shall be tested at the Contractor's factory prior to shipment to Torrance Transit Systems. These factory tests shall fully exercise functionality of the subsystems in order to prove out design and interface characteristics. Factory testing shall be intended to simulate the installed environment as closely as practical.
- Core First Article (CFA) testing shall be conducted, with all components installed on a selected set of Torrance Transit Systems buses in order to demonstrate substantial progress and to identify and document the installed System Component physical configuration. Field Testing shall prove out the system functionality prior to introduction to revenue service.
- Following this, TOM shall be implemented on the full fleet. The field testing shall be closely coordinated through the Contractor's cut-over plan. System Components shall be evaluated on the full fleet in revenue service through an extended reporting period.

- The final acceptance tests shall be conducted to identify and correct any deficiencies found through use of TOM for an extended period of time.

All testing shall be conducted in accordance with the approved testing plans and procedures. All test results shall be documented and submitted to Torrance Transit Systems in formal test reports.

The tests shall not disrupt Torrance Transit Systems operations. Regression tests shall be conducted upon the installation of any new software or patches.

9.1 TESTING FACILITIES

The factory testing as described in this Section, shall be performed in controlled, laboratory conditions at the Contractor's facilities or other Torrance Transit Systems approved facility.

The Core First Article Inspection (CFA) tests, as described in this Section shall be performed at the Torrance Transit Systems facility with the computer system, Dispatch Center, CAD, and communication system backbone fully implemented and interconnected via the TOM and the City of Torrance networks. Final versions of all required software shall be installed.

The field and final acceptance testing shall be performed at the Torrance Transit Systems facility upon completion of the TOM installation. These tests shall be conducted while TOM is being used to support revenue service.

9.2 TEST ADMINISTRATION

All tests shall be administered by the Contractor under Torrance Transit Systems supervision. The Contractor shall provide maintenance for the System Components as necessary during the tests. This maintenance shall be noted by the Contractor in a log to be sent to Torrance Transit Systems. The log shall remain the property of Torrance Transit Systems.

9.2.1 Test Equipment and Personnel

The Contractor shall furnish all test equipment and personnel. The test equipment shall have been calibrated within one year of date of test by a method recognized in the industry. The test personnel shall be properly trained, experienced technicians who are intimately familiar with the system.

9.2.2 Trouble Call

A trouble call is defined as a call for repair service, except for calls due to negligence of Torrance Transit Systems, vehicular collision, abuse of hardware or software, operator error, acts of God, "no trouble found", or other reason clearly not attributable to the hardware or software reliability. For each valid trouble call, the nature of complaint and correction/repair made shall be documented.

9.3 TEST RESULTS REVIEW

All testing and interpretation of results will be the responsibility of TTS' designated test administrator. TTS' test administrator will review the information and data provided by the Contractor and determine whether the system components, subsystems, and/or integrated system have performed in accordance with the Agreement and Specifications.

The Contractor shall provide TTS' designated test administrator with a minimum of four weeks advance notice of each scheduled test and the opportunity to inspect system components and observe all testing at the Contractor's factory and the Torrance Transit Systems facility.

9.4 SUBMITTALS

The Contractor shall submit detailed procedures for each test described herein <CDRL> for Torrance Transit Systems approval. The requirements for test procedures submittals shall be as per Section 5.

The Contractor shall submit documentation for all test results <CDRL> for Torrance Transit Systems approval, including the results for failed tests. The requirements for the test results reporting shall be as per Section 5.

9.5 CLASS FAILURE

Repeated malfunctions of similar System Components or subsystems shall be considered as a single Class Failure. The Class failures shall be formally assessed during the CFA, and final System Acceptance Test periods, according to the following table:

Test	Test Period	Criteria for Class Failure
CFA	14 days	For each type of System Component, 3% of the installed quantity of the System Component or two (2), whichever is greater.
Final	1 Month	For each type of System Component, 8% of the installed quantity of the System Component or four (4), whichever is greater.

All system components that experience a Class Failure during the acceptance testing shall be replaced by the Contractor prior to acceptance by Torrance Transit Systems. The failures and corrective time for such components shall be counted in determining the system reliability. In the event a Class Failure occurs, the acceptance testing shall be terminated and the cause of the Class Failure shall be corrected. The acceptance testing shall be restarted after the correction of the Class Failure.

In the interpretation of any failure, malfunction, error or other event during the test, the determination of the Torrance Transit Systems test administrator will be final.

9.6 REPORTING REQUIREMENTS

During the acceptance test period, the data transfer functions and data accuracy and integrity shall be monitored. All failures that are not attributable to the operation of a specific System Component shall be recorded as network failures. The network failures shall also include the failure to produce a report and the failure to register an alarm condition. Torrance Transit Systems shall be informed, in writing, of any network failures within five (5) days of occurrence <CDRL> and the Contractor shall take corrective action to alleviate such failures. Any system failure or condition that is not meeting the Contract requirements and/or not reported by the Contractor shall result in a restart of the acceptance testing period for the Article under test.

9.7 TESTING OF EQUIPMENT ELEMENTS

The Contractor shall demonstrate that each field replaceable System Component of TOM meets or exceeds the requirements of the Agreement or this Specification. In cases where the field replaceable unit or subsystem in question is substantially similar in design and application to a System Component previously used in a similar application, the design may be qualified through submission of revenue service data, subject to Torrance Transit Systems approval.

In all other cases, the Contractor shall be required to conduct a proof-of-design test that demonstrates that all requirements of the Agreement and this Specification, including environmental requirements, are met. If a test is failed, the Contractor shall make any necessary modifications to the System Component and rerun the tests until they are successfully completed.

9.7.1 Quality Assurance Testing

As an integral part of their QA programs, the Contractor and sub-suppliers shall perform production inspections and tests on each System Component that is produced as an integral part of their quality assurance program. These inspections and tests shall verify that all System Components contain the correct materials, are assembled properly, and function properly. Torrance Transit Systems may choose to observe, participate in,

conduct, or repeat testing on any item to confirm the validity of the Contractor's test procedures and results.

The Contractor shall perform production inspections and tests at the point of manufacture on all System Components and on each completed subsystem prior to each shipment. These inspections and tests shall verify that each System Component is produced to at least the same quality level as the unit presented for the factory acceptance test.

The production inspection and testing sheets and procedures shall be updated based upon experience gained from subsequent testing or System Component operation. The test procedures shall be expanded to focus on areas that prove to be, or have historically been, troublesome. If approved by Torrance Transit Systems, the tests may be simplified in areas where there is a high degree of confidence that the System Component meets the requirements.

Complete records shall be kept of all production inspections and tests that are performed. Any failures and subsequent corrective measures shall be noted. These records shall be submitted to Torrance Transit Systems for each occurrence. Successful completion of the production inspections and tests on all System Components shall be a prerequisite for the installation of the System Component on Torrance Transit Systems property.

9.8 ONBOARD SUBSYSTEM DEMONSTRATION

The Contractor shall install pre-production units and mock-ups of equipment on two Torrance Transit Systems buses for the purpose of demonstrating progress in the design development and to provide Torrance Transit Systems personnel with a preview of TOM. To the extent possible, the Onboard TOM System Components shall function individually.

9.9 FACTORY TESTING

The factory acceptance tests (FAT) shall verify the major TOM System Components are in compliance with the Agreement and this Specification, prior to the delivery of the System Components to TTS. Related System Components may be integrated and tested together to verify compliance of the individual System Components and their interface(s).

The interfaces between System Components are viewed as crucial aspects of System design. To verify these interfaces, Subsystem tests shall include as many subsystems interfaced together as possible.

9.9.1 Onboard Subsystem

Complete Onboard TOM subsystems incorporating the following System Components shall be tested: Onboard TOM processor, mobile data terminal (MDT), voice mobile

radio, data mobile radio or cellular modem, DGPS receiver, dead reckoning navigation unit, wireless LAN spread spectrum radio, and power conditioning. Wireless communications via the voice radio, data radio or cellular modem, and wireless LAN spread spectrum radio shall be simulated at signal levels to resemble installed conditions. Any additional selected optional components such as AVA, APC, and VHM subsystem components shall also be tested.

Testing shall be initially performed on two units as a proof of design, prior to general production. At least five percent of the Onboard subsystems shall be factory tested prior to shipment to Torrance Transit Systems.

The testing shall verify complete Onboard subsystem functionality, as per Section 3.8 of this Specification, including the following:

- Operator log-in via keypad
- Verification of operator work assignment
- Use of MDT for voice radio calls
- Activation and reporting of SAS
- Use of MDT for text messaging
- Acquisition of GPS derived vehicle location
- AVL functionality with GPS signal lost
- AVL reporting
- Time of day synchronization
- Transfer of data via wireless LAN
- Acquisition and storage of APC data (option)
- Acquisition and storage of VHM data (option)
- AVA audio and text announcements (option)
- Headsign control

9.9.2 Supervisor Subsystem (Option)

A complete Supervisor subsystem incorporating the following system components shall be tested: In-vehicle TOM processor, interface to existing voice mobile radio, MDT, data radio or cellular data modem, DGPS receiver, dead reckoning navigation unit, wireless LAN spread spectrum radio, and power conditioning. In addition, interfaces to the odometer inputs shall be simulated. Communications via the voice radio, data radio or cellular data modem, MDT, and wireless LAN spread spectrum radio shall be simulated at signal levels that resemble installed conditions.

The testing shall be initially performed on one unit as a proof of design, prior to general production. At least one Supervisor subsystem shall be factory tested prior to shipment to TTS.

The testing shall verify complete Supervisor Subsystem functionality as per Section 3.10 and 4.8 of this Specification, including the following:

- Supervisor log-in

- Acquisition of GPS derived vehicle location
- AVL functionality with GPS signal lost
- AVL reporting
- Time of day synchronization
- Transfer of data via wireless LAN

9.9.3 Road Supervisor Subsystem (Option)

A complete Road Supervisor subsystem incorporating the following System Components shall be tested: In-vehicle TOM processor, mobile data computer, voice mobile radio, data mobile radio or cellular modem, DGPS receiver, dead reckoning navigation unit, wireless LAN spread spectrum radio, and power conditioning. In addition, interfaces to the odometer inputs shall be simulated. Wireless communications via the voice radio, data radio, and wireless LAN spread spectrum radio shall be simulated at signal levels that resemble installed conditions.

The esting shall be initially performed on one unit as a proof of design, prior to general production. At least one of the Road Supervisor subsystems shall be factory tested prior to shipment to Torrance Transit Systems.

The testing shall verify complete Road Supervisor subsystem functionality, as per the Agreement and Section 3.10 and 4.9 of this Specification, including the following:

- Supervisor log-in
- Use of MDC to initiate radio calls to buses
- Use of MDC for sending and receiving text messaging
- AVL functionality with GPS signal lost
- AVL reporting
- Time of day synchronization
- Use of MDC to view bus location and status
- Use of MDC to open and complete an Incident Report

9.9.4 Yard Subsystem

The Yard subsystem components shall be factory tested prior to shipment to Torrance Transit Systems. The Yard workstation, LAN, wireless LAN AP, and WAN (if applicable) shall be interconnected and tested as a unit. An interface to the Dispatch Center via the LAN/WAN connection shall be simulated. Communications with buses via the wireless LAN shall be simulated at appropriate signal strength levels.

The testing shall verify the complete functionality of the Yard subsystem. And shall include the following items:

- Functionality of the user interface for the Yard workstation(s)
- Use of Yard workstation to view bus and non revenue vehicle locations and status

- Use of Yard workstation to receive road calls
- Download of route and schedule database copy from the Dispatch Center
- Upload of route and schedule database to buses via the wireless LAN
- Upload of AVA and BSP (option) databases to buses via the wireless LAN (options)
- Download of APC (option), VHM (option), and AVA (option) data from buses via the wireless LAN
- Creation and editing of operator to bus assignment (option)
- Display of yard layout, creation and editing of bus locations plan (option)

9.9.5 Dispatch Center

The complete set of Dispatch Center system components shall be factory tested as a whole. A representative sample of dispatcher consoles may be utilized as long as sufficient network traffic is induced to simulate the full set of dispatcher consoles for loading and response time testing. An interface to the TDB and Torrance LAN/WAN shall be simulated for the purpose of verification of data transfer.

The testing shall verify the complete functionality of the Dispatch Center, including dispatcher consoles, management consoles, TOM servers, TOM LAN, TOM alarm reporting, failure modes, TOM WAN (if applicable), interface to fixed radio site(s) and/or cellular network, and report generation.

At a minimum, all functions identified in the Software Requirements Specification shall be tested, including the following:

- AVL map display functionality
- Tabular listing of vehicle status and incidents
- Incident report creation and accuracy verification
- Report generation functionality and accuracy verification
- Custom report queries
- SAS processing
- Voice calls
- Sending and receiving data messages
- System login
- Remote login of bus operators
- Schedule import from TTS Trapeze FX
- Interface with the TDB
- Retrieving radio calls from the logging recorder
- Verification of compliance with system response time requirements in Section 3 of this Specification.
- Verification of compliance with the single point of failure and availability requirements in Section 3 of this Specification.
- Peak activity loading shall be tested using simulated system events representing up to 150% of the expected quantity of system events

- System re-start capability shall be exercised by repeatedly shutting down and re-starting all processes, over a twenty-four hour period.

9.10 CORE SYSTEM-FIRST ARTICLE

The Core First Article shall demonstrate the installed fixed end TOM subsystems and the installed Onboard TOM subsystems meet or exceed the requirements in the Agreement and this Specification. The Core First Article testing shall not commence until all fixed end system components, system components for one bus of each type listed in Appendix D, and materials of the Contract have been delivered and installed; all system interfaces have been established; and the "debugging" has been completed. At a minimum, implementation of the following system components shall have been completed:

- Complete interface to the TTS voice radio system
- If a data radio system is implmented, fixed radio subsystem and network infrastructure shall be operational at one site, on the data channel.
- If a cellular data network is implemented, the interface to the cellular network
- Yard System shall be operational
- At least one dispatcher console shall be operational
- Onboard subsystems, including:
  - Voice radio interface
  - Data radio or cellular modem
  - Wireless LAN spread spectrum radio
  - Onboard TOM processor
  - Mobile data terminal
  - AVL
  - APC (option)
  - AVA(option)
  - VHM(option)
- At least one Supervisor Subsystem
- At least one Road Supervisor Subsystem (option)

Before any other TOM subsystem installation or testing takes place, the Contractor shall have established and successfully tested the network infrastructure and radio backbone.

The testing shall use data collected from from the installed vehicles and subsystems—no simulated data shall be used. The Core First Article test plan shall be submitted by the Contractor at the Final Design Review. At a minimum, the following functions shall be tested:

- Voice call functionality
- Sending and receiving canned and text messaging
- All CAD and schedule adherence display functions
- Route adherence tracking and route deviation alarms
- MDT functionality
- Data radio or cellular data network coverage

- AVL map display functionality, updates, zoom, icons, configurations, and display accuracy
- AVL tracking accuracy and polling rate
- Tabular listing of vehicle status and incidents
- Headway display
- CAD and map display of route and schedule adherence and accuracy verification
- CAD information and map display correlation
- Incident report creation
- Report generation functionality and accuracy verification
- Custom report queries functionality
- Audio playback functionality
- Logging recorder functionality
- Silent alarm activation, covert mic monitoring, map display, MDT display, and the clearing of a silent alarm
- System login via the MDTs and workstations
- Remote login of bus operators
- Schedule import from the TTS Trapeze system and other Trapeze interfaces
- Interface with the TDB and other TTS systems
- Single sign on with the farebox and other farebox interfaces (option)
- AVA functionality and accuracy verification (option)
- Add, modify, and delete AVA announcements (option)
- APC functionality and accuracy verification (option)
- Headsign control
- VHM functionality and alarm reporting via the wireless data communications (option)
- Wireless LAN functionality
- Schedule downloads to vehicles
- Yard workstation management of downloads
- Display of road calls on Yard workstation
- Playback functionality and accuracy
- Supervisor subsystem functionality
- Road Supervisor subsystem functionality (option)
- Passenger information prediction functionality
- Voice communication with failed CAD and failed Onboard TOM subsystem
- Verification of compliance with the single point of failure requirements in Section 3 of this Specification.
- Failure sensing, switchover, and system recovery
- Recovery from simulated failures

The Contractor shall complete all training for the bus operator trainers and the Transit Supervisors prior to the initiation of the Core First Article testing.

The exact installation details shall be fully documented during this process, since these units shall be the prototypes for all subsequent vehicle installations. The Onboard TOM subsystems shall be fully functionally tested, including use in simulated revenue service.

9.10.1 Fixed Radio Equipment

If a data radio system is implemented, the following requirements in this section shall apply.

All fixed radio system components furnished by the Contractor shall be tested for performance. The Contractor shall demonstrate to TTS that the data radio system components meet or exceed the performance level of requirements specified in the Agreement and this Specification or manufacturer's advertised ratings. The tests shall include as many of the following parameters as are appropriate for the item:

- Transmit/receive frequency error
- Modulation level
- Forward and reflected power at combiner output
- Insertion loss of combiner
- Receiver sensitivity
- Local operating controls
- Alarms and monitoring
- Base station disable upon failure or performance degradation below a pre-set limit
- Telephone interface, if applicable
- Installed/specified options
- Console features and controls
- System administrator features and installed/specified options

9.10.2 Wireless Data Communication Coverage Testing

The testing of the wireless data coverage shall be performed in accordance with a detailed procedure developed by the Contractor and submitted to TTS for approval. The purpose of the coverage tests shall be to demonstrate that TOM wireless data communication system operates in accordance with the coverage requirements for the data radio system as stated in Section 3 and 4 of this Specification. The test procedure submittal shall demonstrate the radio system is in compliance with the technical specifications.

The wireless data communication subsystem shall be subjected to a coverage test as described herein.

9.10.2.1 Area

The covered area shall be divided into sectors, each approximately one mile by one mile. These sectors shall be overlaid on a TTS service area map, provided by TTS and as shown in Appendix H. All sectors which contain a portion of any of TTS bus routes shall be tested. Results from all sectors tested shall be used in calculating overall pass/fail percentages.

9.10.2.2 Test Set-Up

If a data radio system is implemented, the installed fixed radio base stations shall be used for the tests.
A mobile test set-up shall be installed on a Contractor-provided test vehicle. The mobile test set-up shall be adjusted to match the actual transmit and receive parameters of a typical onboard subsystem installed on a bus, as determined by actual measurement of ERP, and antenna losses on buses. The mobile test set-up shall also compensate for differences in antenna height, ground plane efficiency, and the appropriate signal strength allowance to achieve 95% reliability (as opposed to the average or median signal strength assumed to be present during tests.)

9.10.2.3 Test Measurements

Talk-out and talkback tests shall be performed on the data radio channel(s) or cellular network in each sector. Tests that measure only signal strength shall not be acceptable, the RSSI levels shall be measured. If applicable, simulcast channels shall be operated in simulcast mode during testing. Each test in each sector shall consist of at least ten measurements, with the average used. Measurements shall be taken sequentially while in motion. A GPS receiver shall be utilized to provide the location for each test measurement. All measurements shall be recorded.

9.10.2.4 Test Report

The test report shall include: the complete test procedure, drawings of the test set-up, pass/fail criteria, all formulas used in processing the data for comparison to the pass/fail criteria, the raw measurements taken, and the processed (calculated) results for each sector. A summary of the overall test results, including any recommendations for re-testing, is required. Re-testing shall be required in event TOM fails to pass the performance requirements in Sections 3 and 4 of this Specification.

9.11 SYSTEM ACCEPTANCE TESTING

The System Acceptance testing shall demonstrate the entire fully integrated TOM system is in compliance with the Agreement and this Specification. The acceptance testing shall not commence until all fixed station System Components and materials of the Contract have been delivered and installed and "debugging" has been completed. All training prior to initiation of the acceptance testing. Upon completion of theinstallations, interfacing, and implementation of all TOM System Components and subsystems including all buses and supervisor vehicles, a 30 day formal acceptance testing period shall commence, during which the Contractor shall conduct the following sections.

Defects found by Torrance Transit Systems during the System Acceptance testing shall be promptly reported to the Contractor for repair/correction at Contractor's sole cost and expense. Each repair/correction shall be documented to Torrance Transit Systems <CDRL>.

9.11.1 Integrated System Functional Test

The System Acceptance testing shall, at a minimum include the following:

- Voice calls including Group Calls and All-Calls functionality
- Text messaging including text announcements to a bus, subgroup, group, line, all buses, or supervisor vehicles.
- Audio announcements by a dispatcher on the PA system of a selected bus or a group of buses
- SAS functionality including map display of nearest vehicles to bus in the SAS alarm state
- Data transmission throughput measurements
- AVL map display functionality, updates, zoom, icons, configurations, and display accuracy
- AVL tracking accuracy and polling rate
- Tabular listing of vehicle status and incidents
- System login via the MDTs and workstations
- Remote login of bus operators
- Schedule import from TTS' Trapeze system and other Trapeze interfaces
- Interface with the TDB, TTS LAN/WAN, and other TTS systems
- Report generation functionality and accuracy verification
- Custom report queries functionality
- Voice communication with failed CAD and failed Onboard TOM subsystem
- VHM functionality and alarm reporting via the wireless data communications (option)
- Schedule downloads to vehicles
- Yard workstation management of downloads
- Display of road calls on Yard workstation
- Supervisor subsystem functionality
- Road Supervisor subsystem functionality (option)
- Webpage functionality (option)
- Memory management measurements
- Schedule adherence CAD and map displays
- Schedule adherence accuracy and change in schedule tolerance functionality
- CPU loading measurements
- Response times with voice and data communications, and TOM data traffic loads for a worst case busy hour
- Playback functionality and accuracy
- AVA functionality and accuracy verification (option)
- Correlation between supplied documentation and actual operation
- Accuracy of Traveler Information System data
- Accuracy of information provided on webpage (option)
- Add, modify, and delete routes and webpage (option)
- Add, modify and delete messages on webpage (option)
- Add, modify, and delete pulldown menus on webpage (option)
- Accuracy of all APC data and reports (option)
- Accuracy of VHM data and reports (option)

- Interface to RIITS and 511
- Data archival and retrieval

9.11.2 Human Factors Test

The purpose of this test is to verify that those features and operating characteristics that affect the operator's use of each System Component are easy to understand, easy to use, and that they respond quickly to operator actions. This test may be conducted as an integral part of the functional tests. The overall goal of this test is to ensure that the System Components have been designed with attention to ergonomics, efficiency, and safety for all Torrance Transit Systems personnel that interact with TOM.

- The Contractor shall participate with the Testing Review Board to analyze problems reported by TOM users that are attributed to "user error" to determine if the "user error" is in fact attributable to a difficult or confusing interface.
- The Contractor shall monitor the training programs to determine TOM functions that Torrance Transit Systems personnel are consistently having difficulty utilizing.
- The Contractor shall participate with the Testing Review Board in analyzing complaints from operators, supervisors, dispatchers and other personnel regarding ergonomics of using TOM.

The Contractor shall summarize results of these activities and recommend a course of corrective action, such as modification of the interface, additional user training, or adjustment of System Component mounting <CDRL>.

9.11.3 Major Failure

Any major failure of a System Component during the System Acceptance test period shall be cause to stop the acceptance test procedure until repairs are made, at which time a new System Acceptance test shall begin. Major failures include, but are not limited to:

- Crash of any dispatch console or TOM application lockup
- Crash of a voice or data channel, if applicable.
- Crash of the CAD system requiring a reboot or a CAD system slowdown.
- System recovery failure
- Crash of schedule adherence functionality and/or TOM subsystem which interrupts the tracking of all vehicles.
- Busy indication or lockout on a data radio channel or inability to access the cellular data network
- Crash of the website (option)
- Failure of the logging recorder
- Loss of access to the TOM databases.
- More than one spontaneous switchover to redundant equipment which requires repair or replacement of a failed module.

- Any fixed data radio base station, cellular data modem, or mobile data radio that remains on the air for an excessive amount of the time for any reason not related to operator error, vehicular collision, or act of God.
- Demonstrably slow response of the CAD or other TOM subsystem during busy periods.
- Count of trouble calls exceeding more than:
  - One call for a radio, CAD, or TOM console electronics/display failure on any day;
  - 2% of the control stations or mobile radios per day
  - One call per day for loss of feature or trouble executing any CAD or other TOM function or display, not related to operator error
  - One call for a website failure on any day (option)
  - One call for an electronic Display failure on any day (option)

9.11.4 Database Validation

The TOM databases shall be validated; including the route and schedule database, stops database, webpage database (option), APC database (option), AVA audio and visual announcement database (option), VHM database (option), and GIS maps. The databases shall be validated through generation of reports and analysis of all reported "abnormal conditions" to determine whether the reported "abnormal conditions" are due to a database anomaly:

- Off-route and off-schedule reporting parameters shall be set to their minimum values
- Reports of incorrect time of arrival predictions shall be investigated.
- Reports of incorrect website predictions shall be investigated. (option)
- Quantities of APC transactions that are not attributed to a known stop shall be analyzed. (option)
- Reports of incorrect APC (option) and VHM data (option) shall be investigated.
- Reports of incorrect AVA announcements shall be investigated (option)
- The dispatcher consoles shall be monitored for correct display of bus locations, within street boundaries, and verifying their route adherence status.

Abnormal conditions shall be recorded and investigated to determine if systemic errors exist. The deficiencies shall be corrected. Documentation of abnormalities and corrections shall be furnished to Torrance Transit Systems <CDRL>.

9.11.5 System Acceptance 30-Day Monitoring

The Contractor shall continue to provide an on-site test representative for one month from the inception of the System Acceptance Tests. The representative shall work with the TTS test administrator to investigate and categorize TOM failures and to work with Torrance Transit Systems to repair TOM related failures, as part of the warranty, as described in the warranty agreement.

At the end of this time, the Contractor shall prepare a report assessing the system performance vs. availability and reliability requirements <CDRL> and a report noting compliance with all parapgraphs of the technical specification. Corrective actions shall be suggested if TOM does not achieve the required reliability and availability. Torrance Transit Systems will review the recommended corrections and provide guidance to the Contractor regarding the Contractor's actions to correct any deficiencies.

10 SUBMITTALS AND DESIGN REVIEWS

This Section also defines the requirements for the Contractor to hold formal design reviews with Torrance Transit Systems. The Contractor shall submit information with the proposal for evaluation and at the preliminary and final design levels for review and approval by Torrance Transit Systems.

Additional submittals are required as appropriate to the work. The submittals are described in individual sections of this Specification (refer to Appendix J), Contract Deliverables Requirements Listing <CDRL>. The format for submittals shall be as per Section 4 of this Specification.

10.1 SUBMITTALS WITH PROPOSAL

The following technical information shall be included with the proposals.

10.1.1 System Overview

A complete written description of the proposed system shall be provided that clarifies the available functions, user interfaces, and all equipment shall be provided. Top-level block diagrams shall be included. The descriptions shall be explicit regarding all equipment and functions to be included.

10.1.1.1 Compliance Matrix

The proposers shall create and provide a compliance matrix listing each requirement in this specification and the proposer's intention to comply or not comply with each requirement. The proposers shall indicate "C" for compliance or "E" for non compliance. All non "C" designations will be considered as a non compliance.

10.1.1.2 Equipment Descriptions

Manufacturer data sheets for all major components of TOM, both hardware and software, shall be provided. The data sheets shall be edited or highlighted to indicate the specific models, features, and options that are proposed.

10.1.1.3 Open Architecture Analysis

For each interface between onboard equipment, the proposers shall describe the interface type and the standards to be used. If open standards are not used, proposers shall state the rationale for the decision.

10.1.2 Data Radio System Information

If a data radio system is proposed the following requirements shall apply.

The proposers shall identify the proposed site(s) and radio coverage maps for each proposed site and a composite coverage map from all sites. The coverage maps shall illustrate the area covered from each site, based on USGS terrain database, expected antenna heights, and the appropriate urban RF model for the area. Coverage maps shall show signal level variations at 5 dB maximum intervals utilizing contours and color codes. Coverage shall be as defined in this Specification.

10.1.2.1 Data Radio Coverage Maps

Separate maps for data radio coverage for each site and composite shall be provided showing talk-out and talkback coverage. If applicable, the coverage map shall indicate the overlap coverage areas and areas where phasing delay will inhibit data.

10.1.2.2 Transmit Parameters

The proposers shall provide calculations showing transmitter power, antenna network loss (for each individual component), and the ERP for each fixed transmitter and mobile.

10.1.2.3 Receive Parameters

The proposers shall provide calculations showing the minimum required signal level based on receiver sensitivity; and the net signal gain or loss due to antenna gain, receive line losses (for each individual component), and receive multicoupler gain for each fixed receiver and mobile.

10.1.2.4 Data Channel

The proposers shall provide a calculation showing the expected and worst case percent utilization for the data channel to be used for the data radio system. The proposers shall provide an accompanying narrative explaining the calculation and assumptions made.

10.1.3 Wireless Data Service Coverage Layout

If a cellular data service is proposed, the requirements in this section shall apply.

The proposed wireless data service provider shall be identified and a coverage map shall be provided. The coverage map shall show signal level variations at 5 dB maximum intervals utilizing contours and color codes. The coverage shall be as defined in this Specification.

10.1.4 Call Set-Up

A description of the data flow required for an SAS, PRTT, and RTT from the activation at the mobile to the display at the target dispatcher's console of the vehicle location. Provide a description of the data flow from dispatcher selection of the call to audio communications with the operator. These descriptions shall include the message length, and the expected processing time for each segment of the call set-up.

10.1.5 Description of Most Similar System

The proposer shall provide a description of another APTS or SmartBus System that has been completed or is nearly completed by the proposer that most closely resembles TOM. The description shall summarize similarities and differences in the system functionality, use of open architecture, use of NTCIP standards, compliance with national ITS architecture requirements, performance requirements, fleet size, cut-over, and implementation schedule.

10.1.6 Description of the Software To Be Developed

The proposer shall provide a comparison of the functionality of the existing software modules for the proposer's standard product to the TOM functionality requirements, and a description of the process that will be used to develop new software to provide the specified TOM functionality. An estimate of the quantity of the software modules, lines of new software code required, and new database sizes shall be included.

10.1.7 Spares and Test Equipment

The proposer shall provide a complete list of the spares and test equipment necessary for the long-term maintenance of TOM to meet the availability and maintainability requirements specified for TOM. This list shall include the equipment specified in Section 8 and additional equipment recommeded to support the proposer's TOM design.

10.1.8 Additional Items To Be Provided in the Proposal

- Description of five systems similar to TOM that have been implemented by the proposer and have been accepted for at least one year
- List of how the proposal varies from any approach set forth in the RFP, the benefits of their approach, and the implications of their alternative. Proposals shall be clear in describing the exact approach intended.
- A description of the proposer's standard offering in the proposal and highlight the proposed features that exceed specification requirements, and the features that need to be developed to meet the specifications
- An explanation of how functions designated as future or options can be added to TOM at a later time

- The accuracy of the time of arrival predictions for previously implemented systems
- A detailed description of the algorithm for the time of arrival predictions
- A description of the IT support and communication maintenance support necessary to maintain TOM
- Examples of APC accuracy test results from tests performed at previous client Agencies showing the expected accuracy of the APC subsystem
- Identify locations for the onboard equipment
- Description and examples of TOM fleet management reports reports to be provided
- Information on the proposed mounts for the Supervisor equipment for the various TTS vehicles, i.e. car, van, truck, etc.
- Information on the proposed mounts for the Road Supervisor equipment for the various TTS vehicles, i.e. car, van, truck, etc
- A cost proposal for commercial wireless data service for data transmissions with Road Supervisor MDCs
- The names and resumes of the proposed project staff, including the Project Manager and STSM

10.2 PRELIMINARY DESIGN SUBMITTAL

The Contractor shall provide a preliminary design submittal <CDRL> within ninety (90) days after Notice to Proceed. This submittal shall be reviewed in detail with Torrance Transit Systems and their designated representatives to verify that all aspects of the Contractor's design are in conformance with the Specification requirements and are fully understood by Torrance Transit Systems. In the event additional elements are planned for a subsequent implementation, those elements shall also be addressed detailing the TOM capacity that will be necessary for the additional elements. The Contractor shall demonstrate that additional elements could be added later without an adverse impact to the current hardware and software being implemented. The Contractor shall submit at least three printed copies and one electronic copy in a format that is accessible by Torrance Transit Systems.

10.2.1 Overview

The preliminary design submittal shall include a complete description of each VCA subsystem and system component, updates of the technical information submitted with the proposal, and an updated detailed project schedule. At a minimum, the overview shall describe the CAD functionality, voice and data communication functionality, passenger information functionality, Supervisor and Road Supervisor (option) subsystems, as well as the functionality of optional items that have been exercised. Preliminary installation drawings for the Computer subsystem, dispatcher workstations, and Onboard VCA subsystems shall be presented

10.2.2 Software Requirements Specification

The Contractor shall submit a draft Software Requirements Specification document based upon IEEE 830, Recommended Practice for Software Requirements Specifications Software Requirements Specification <CDRL>. It shall cover the software documentation for any new functionality that is being developed for TOM with an emphasis on the user interfaces, and interfaces to external systems. While the complete document will be submitted, it is not the intent of Torrance Transit Systems to review or approve the internal workings of the software. The Contractor shall submit the first draft of the Software Requirements Specification document within forty-five (45) days after Notice to Proceed, and a revised version to coincide with the Preliminary Design Review submittal.

10.2.3 Manufacturer Data Sheets

The preliminary design submittal shall include data sheets for all major hardware and off-the-shelf software components.

10.2.4 CAD User Interface and Functionality

The preliminary design submittal shall include a complete description of the CAD user interface including CAD features, AVL map displays, tabular displays, incident reports, SAS functionality, voice and data communication functions, fleet management reports and custom queries, AVL playback, incident reports, sample screens, a list of the pull down menus and items, and all software interfaces.

10.2.5 Computer Subsystem

The preliminary design submittal shall include a complete description of the Computer subsystem including the servers, dispatcher workstations, monitoring workstations, Yard workstation, interfaces, UPS, data archival, TDB, and installation information.

10.2.6 Data Radio System Information

If a data radio system is implemented, the requirements in the following sections shall apply.

The Contractor shall identify the proposed site(s) for the data radio system and provide radio coverage maps for each proposed site and a composite coverage map from all sites. The coverage maps shall illustrate the area covered from each site, based on USGS terrain database, expected antenna heights, and the appropriate urban RF model for the area. The coverage maps shall also show signal level variations at 5 dB maximum

intervals utilizing contours and color codes. Coverage shall be as defined in this Specification.

10.2.6.1 Data Radio Coverage Map

Separate maps for data radio coverage for each site and composite shall be provided showing talk-out and talkback coverage. If applicable, the coverage map shall indicate the overlap coverage areas and areas where phasing delay will inhibit data.

10.2.6.2 Transmit Parameters

The Contractor shall provide calculations showing transmitter power, antenna network loss (for each individual component), and the ERP for each fixed transmitter and mobile.

10.2.6.3 Receive Parameters

The Contractor shall provide calculations showing the minimum required signal level based on receiver sensitivity; and the net signal gain or loss due to antenna gain, receive line losses (for each individual component), and receive multicoupler gain for each fixed receiver and mobile.

10.2.6.4 Data Channel

The Contractor shall provide a calculation showing the expected and worst case percent utilization for the data channel to be used for the data radio system. The proposers shall provide an accompanying narrative explaining the calculation and assumptions made.

10.2.7 Wireless Data Service Coverage Layout

If a cellular data service is implemented, the requirements in this section shall apply.

The wireless data service provider shall be identified and a coverage map shall be provided. The coverage map shall show signal level variations at 5 dB maximum intervals utilizing contours and color codes. The coverage shall be as defined in this Specification.

10.2.8 Call Set-Up

A description of the data flow required for an SAS, PRTT, and RTT from activation at the mobile to display at the target dispatcher's console with the vehicle location shall be provided. A description of the data flow from dispatcher selection of the call to audio communications with the operator shall be provided. These descriptions shall include the channel used for the data, the message length, and the expected processing time for each segment of the call set-up.

10.2.9 Onboard VCA Subsystem

The preliminary design submittal shall include a complete description of the VCA Onboard subsystem including the onboard processor, MDT, optional onboard items that have been exercised, interfaces, and installation information. Descriptions of the Supervisor and Road Supervisor (option) subsystems shall also be provided.

The MDT description shall include scaled drawings MDT with exact key labeling and typical displays. The submittal shall also include a complete description of the operator interface with the MDT including all prompts, displays, and keystrokes for each function.

The MDT description shall include scaled drawings of the MDT with the exact key labeling and typical screen displays. The submittal shall also include a complete description of the operator interface with the MDT including all prompts, displays, and menus.

A description of the functions performed by the Onboard TOM processor and the expected loading of the processor shall be provided. The analysis shall show any expected slowdown in processing data or in data communications, based on the normal and worst-case processor loading for the proposed hardware configuration.

10.2.10Description of the Software To Be Developed

The Contractor shall provide a comparison of the functionality of the existing software modules for the proposer's standard product to the TOM functionality requirements, and a description of the process that will be used to develop new software to provide the specified TOM functionality. The quantity of the software modules, lines of new software code required, and new database sizes shall be included.

10.2.11Description of Route and Schedule Database Handling

A description of the methodology for maintaining TTS' current route and schedule database in Trapeze and its interface with TOM shall be provided. This description shall include how the database will be edited, handled, and interfaced to TOM; and the methodology for providing the database onboard each bus for tracking route and determining schedule adherence. This description shall include an estimate of the required database size, means for updating the information when route and schedule changes occur such as during a "shake-up", how checks for the validity of the modifications are made, and the required operator actions to enter or confirm the assigned route.

10.2.12Traveler Information

A detailed description of the algorithm for the time of arrival predictions shall be provided.

10.2.12.1 Displays (Option)

The preliminary design submittal shall include scaled drawing showing details of the Displays to be furnished and their mounting hardware. The submittal shall also include a complete description of the Display interface with the wired and/or wireless data network used to provide data to the Display and the details for the data network.

10.2.12.2 Traveler Information Website Design (Option)

The preliminary design submittal shall include mockups of the screens for the website. The submittal shall also include a complete description of the website, including a list of the pull down menus and items, a sample map display, and sample time of arrival predictions.

10.3 FINAL DESIGN SUBMITTAL

The Contractor shall provide a final design submittal <CDRL> within four months after the Notice to Proceed. The submittal shall be reviewed in detail with TTS and their designated representatives to verify that all aspects of the Contractor's final design are in conformance with the Specification requirements and are fully understood by TTS. The Contractor shall submit at least three printed copies of the final design submittal and one electronic copy in a format that is accessible by the TTS.

10.3.1 Overview

The final design submittal shall include a complete description of each TOM subsystem and system component, updates to the technical information submitted in the preliminary design submittal, and an updated detailed project schedule. At a minimum, the overview shall provide details of each subsystem and discuss any changes and updates that have been made since the preliminary design submittal to the CAD functionality, voice and data communication functionality, passenger information functionality, Supervisor subsystem, Road Supervisor subsystem (option), as well as the functionality of optional items that have been exercised. Final installation drawings for the Computer subsystem, dispatcher workstations, Yard workstation, WLAN, Displays (option), Onboard TOM subsystems, and optional items that have been excercised shall be provided along with installation plans.

10.3.2 Dispatch Center and Yard, Traveler Information Subsystem Hardware and Software

The final design submittal shall contain sufficient information to determine that the product to be implemented comply with the specifications and that the design is complete with all interfaces defined. The actual values of all specified parameters shall be listed—a simple statement that the product complies will not be sufficient. Engineering drawings shall be provided as necessary. When pre-printed materials are used in a submittal, the specific model number and options to be furnished shall be clearly identified. All interfaces with external systems shall be documented.

10.3.3 Onboard Subsystem Hardware and Software

The final design submittal shall contain sufficient information to determine that all Onboard, Road Supervisor (Option), and Supervisor Subsystem hardware and software comply with the specifications and that the design is complete with all interfaces defined. Actual values of all specified parameters shall be listed—a simple statement that the product complies will not be sufficient. Engineering drawings shall be provided as necessary. When pre-printed materials are used in a submittal, the specific model number and options to be furnished shall be clearly identified. All interfaces with external systems shall be documented.

10.3.3.1 Interconnection Details

The drawings furnished shall show details of all interconnections, including pin assignments, color codes, terminal designations, tag nomenclature, and their functions.

10.3.3.2 Installation Details

The drawings furnished shall show details of the equipment mounting and cable routing for each model of bus and vehicle. Keyed parts list for the mounting hardware shall be included.

10.3.3.3 Onboard Subsystem Installation Plan

The installation plans furnished shall include the number of personnel, expected production per shift, sequence of vehicles, serializing plan, and the requested support from Torrance Transit Systems.

10.3.3.4 Onboard Subsystem Test Procedure

The procedures furnished shall detail tests to verify the proper functionality of each Onboard Subsystem subsequent to the installation. The procedure shall also include tests for the interfaces to TOM.

10.3.4 Computer and Fixed Radio Subsystem (if Applicable) Hardware and Software

10.3.4.1 Interconnection Details

The drawings furnished shall show details of all interconnections, including pin assignments, color codes, terminal designations, tag nomenclature, and their functions.

10.3.4.2 Rack Layouts

The scaled drawings furnished shall show all equipment to be installed in each rack or cabinet.

10.3.4.3 Installation Details

The scaled drawings furnished shall show the arrangement of racks at the TTS facility and/or radio site(s), routing of interconnection cables, routing of power and ground cables, antenna mounting details, and transmission line installation details. The drawings shall show keyed parts list for mounting hardware.

10.3.4.4 Software Description

The final design submittal shall include a complete description of the software and firmware applications being furnished, including the software version and the options selected. In addition, an updated description of the software being developed for TOM and complete interface ICDs to all external systems shall be provided.

10.3.4.5 Test Procedures

A complete procedure shall be provided for the tests and inspections necessary to verify the complete functionality of the installed equipment.

10.4 DESIGN REVIEWS

The Contractor shall conduct formal presentations of the Preliminary Design and the Final Design submittals for TOM. The design review presentations shall be scheduled approximately two weeks after submission of the presentation materials to TTS for review. At least ten copies and one electronic copy in a format that is accessible by Torrance Transit Systems shall be submitted.

Each design review shall be conducted according to the following agenda:

- The Contractor shall present the design submittal in sufficient detail to demonstrate details of achieving compliance with the Contract requirements. Use of mock-ups, samples, and demonstrations of the user graphical user interfaces is encouraged.

- Torrance Transit Systems and its designated representatives shall present issues and concerns for discussion.

The Contractor shall furnish minutes of the design review meetings <CDRL>.

Torrance Transit Systems will follow up each design review with written comments on the design deliverable. The Contractor shall address all of the TTS' issues and concerns in writing <CDRL>. At the sole discretion of Torrance Transit Systems, if the issues and concerns warrant it, Torrance Transit Systems will require an additional design review presentation or design review submittal.

APPENDIX A. GLOSSARY OF ACRONYMS

AC	Alternating Current
ADA	Americans with Disabilities Act
AM	Amplitude Modulation
ANSI	American National Standards Institute
AP	Access Point
APC	Automatic Passenger Counter
API	Application Programming Interface
ATSAC	Automated Traffic Surveillance and Control
AVA	Automatic Voice Annunciation
AVL	Automatic Vehicle Location
BNC	Bayonet Coupled Coaxial Connector- 50 ohm
BSP	Bus Signal Priority
C	Celsius
C/A Code	Coarse/Acquisition Code
CAD	Computer Aided Dispatch
CCITT	Consultative Committee for the International Telegraph and Telephone
CD	Compact Disc
CD-RW	Compact Disc Read Write
CDRL	Contract Deliverables Requirements Listing
CD-ROM	Compact Disc Read-Only Memory
CFA	Core First Article
CNG	Compressed Natural Gas
COTS	Commercial Off The Shelf
dB	Decibel
dBm	Decibel Milliwatt
DC	Direct Current
DGPS	Differential Global Positioning Satellite
DMS	Document Management System
DTMF	Dual Tone - Multi Frequency
DVD-RW	Digital Versatile Disc Read Write
DXF	Drawing Exchange Format
EIA	Electronic Industries Association
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ERP	Effective Radiated Power
ESRI	Environmental System Research Institute
F	Fahrenheit
F3	Form, Fit, and Function
FCC	Federal Communications Commission
FHSS	Frequency Hopping Spread Spectrum
TTS	Torrance Transit Systems
FM	Frequency Modulation
FTA	Federal Transportation Administration

GB	Gigabyte
GHz	Gigahertz
GIS	Geographical Information System
GPS	Global Positioning Satellite
GUI	Graphical User Interface
HVAC	Heating, Ventilation, and Air Conditioning
Hz	Hertz
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ISO	International Standards Organization
ITS	Intelligent Transportation System
ITU	International Telecommunication Union
KHz	Kilohertz
L1	Link 1
LADOT	Los Angeles Department of Transportation
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MB	Megabyte
Mbps	Megabits per Second
MCD	millicandelas
MDC	Mobile Data Computer
MDT	Mobile Data Terminal
MHz	Megahertz
MIL	Military
MPH	Miles per Hour
MTA	Los Angeles County Metropolitan Transportation Authority
NIT	A Unit of Measuring Screen Brightness
NTCIP	National Transportation Communications for ITS Protocol
NTD	National Transit Database
NTP	Notice to Proceed
OSI	Open System Interconnection
PA	Public Announcement
PC	Personal Computer
PCI	Peripheral Component Interconnect
PCI-E	Peripheral Component Interconnect - Express
PPM	Parts per Million
PRTT	Priority Request To Talk
PTT	Push to Talk
QA	Quality Assurance
QWERTY	Keyboard Layout
RAID	Redundant Array of Inexpensive Disks
RAM	Random Access Memory
RF	Radio Frequency
RFI	Radio Frequency Interference

RFP	Request For Proposal
RH	Relative Humidity
RHCP	Right Hand Circular Polarization
RIITS	Regional Integration of Intelligent Transportation System
RMS	Root Mean Squared
RPM	Revolutions per Minute
RTT	Request To Talk
SAE	Society of Automotive Engineers
SAS	Silent Alarm System
SINAD	Signal to Noise and Distortion
TOM	Smart Bus System
SNMP	Simple Network Management Protocol
STSM	Senior Technical Staff Member
TCIP	Transit Communications Interface Profiles
TCP/IP	Transmission Control Protocol/Internet Protocol
TDB	Transit Database
TNC	Threaded Coupled Coaxial Connector- 50 ohm
TTS	Torrance Transit Systems
UFS	Universal Fare System
UPS	Uninterruptible Power Supply
USB	Universal Serial Bus
USGS	United States Geodetic Survey
V	Volt
VAC	Volts Alternating Current
VDC	Volts Direct Current
VHM	Vehicle Health Monitoring
VSS	Video Surveillance System
VSWR	Voltage Standing Wave Ratio
W	Watt(s)
WAAS	Wide Area Augmentation System
WAN	Wide Area Network
W/C Lift	Wheel Chair Lift
WLAN	Wireless Local Area Network

APPENDIX B. PARTIAL LIST OF STANDARD REPORTS

APC Reports

APC Invalid Data	Provides report on erroneous APC data collected from vehicles. Also list faults and failures of APC equipment on vehicles.
Bus Stop Summary	Provides APC counts for each bus stop on a given route.
Bus Stop Trip	Used to view trip specific APC data at the stop level. This report is intended for detailed analysis of boarding for a single trip or small subset of trips for a single day.
Historical Ridership Summary	Used to view past ridership for a Line/Run for the entire day. Summarizes APC counts, passenger distance, passenger hours, passenger miles, and max load information. Intended to be run against a single Line or small subset of lines for an extended period of days.
NTD Trip Detail	Used to view NTD type data at the trip level.
Trip Summary	Provides statistical information about passenger counts for each trip on a given route including passenger miles and vehicle miles.
Uncorrelated Bus Stops	Provides a list of door events by error type that could not be correlated to a specific bus stop
Wheel Chair Passengers	Provides wheelchair ridership information for a Line/Run for the entire day.
NTD	Provides an NTD report for filing with the FTA

Call Status

Call Summary	Provides a long term statistics for the number of calls

Dispatcher Status Reports

Daily Dispatcher Activity	Reports of dispatcher activity and performance on a daily basis. Provides a count of incident data, voice and data calls and incident forms for each controller each hour.

Incident Reports

Incident Summary	Provides a long term statistics for the incidents
Lift Report	Reports wheelchair lift information from incidents that have the lift report attribute set
Logon/Logoff Status	Provides a daily report of operator logons and logoffs
Operator Activity Log	Provides a particular operator's activity on a vehicle for a given period of time
Personnel Status Summary	Provides long term statistics for the personnel status
Vehicle Activity Log	Provides a particular vehicle's activity for a given period of time.
BSP Priority Request Log (Option)	Provides a log of bus signal priority requests for a vehicle, line, and given period of time.

Incident Form Reports

Driver Performance--Braking	Provides a report of vehicle collected accounts of driver harsh acceleration and decelerations
Controller 'Daily Diary' Report	Retrieves incident form data associated with problem code 'DD' which includes notes entered by controller.
Daily Incident Form Distribution	Provides summary of Incident Form creation based on Problem Code distribution
Daily Incident Form Detail Distribution	List all Incident Forms by problem code for the day with additional detail about operator, dispatchers and division
Daily Incident Form Summary	Summarizes the incident form for a specific date. The report computes the number of pending forms at the start of the day, new forms created, forms closed and the number of forms pending at the end of the day.
Daily Vehicle Problem	Dispatcher entered descriptions of all vehicle problems
Extra Service Report	Reports all dispatcher-entered Extra Service
Incident Form Summary	Provides a long term statistics for the incident forms
Silent Alarm	Provides daily statistics for all emergency alarms within the dates specified

Miscellaneous Reports

Daily Detour	Provides a report on currently active detours
Mileage	Provides daily information on vehicle mileage

Weather Report	Dispatcher entered weather descriptions

RSA Reports

Current Service Status	Reports counts for all logged on vehicles, vehicles logged on for each type, vehicles logged on that are running an active route, vehicles on time, early, late, and number of runs missed.
Daily Route and Schedule Adherence by Trip	Provides statistics on schedule adherence on trips
Daily Route and Schedule Adherence by Workrun	Provides statistics on schedule adherence on workruns
Line/Run Status Report	Daily report of line and run status
Passenger Mileage	Provides total passenger miles collected by Run and by Route
Route Schedule Graphical Chart	Graphical display of route and schedule adherence
Route Schedule Summary	Provides a long term statistics for the schedule adherence
Route Schedule Adherence Detail	Reports statistics on route and schedule adherence
Schedule Adherence at Timepoint	Reports statistics on early and late schedule adherence at timepoints

Vehicle Status Reports

Vehicle Inventory	Provides an inventory listing firmware version, data version and serial number of devices on board the vehicle
Vehicle Use	Provides a report on bus usage per half hour increments.

APPENDIX C. PARTIAL LIST OF CANNED MESSAGES

The following is a representative sample of the canned messages that the Contractor shall furnish with TOM. TTS may modify this list during the initial phase of the project.

MESSAGES FROM DISPATCH:

Msg ID	Default Response	Description
1	Ack	See Transit Operations Manager
2	Ack	See Training & Safety Instructor
3	Ack	See Transit Operations Supervisor
4	Ack	Phone Operations Division
5	Ack	PD will meet in route
6	Ack	Mech. will meet in route
7	Ack	Continue in route
8	Ack	Continue with caution
9	Ack	Hold your position
10	Ack	Hold @ L/O for Mech
11	Ack	Hold @ L/O for Supv
12	Ack	Hold @ L/O for PD
13	Ack	Hold @ next stop for Mech
14	Ack	Hold @ next stop for Supv
15	Ack	Hold @ next stop for PD
16	Ack	Medical responding
17	Ack	Fire Depart. responding
18	Ack	Mech. responding
19	Ack	Get courtesy cards
20	Ack	Complete accid./incid. report
21	Ack	Bus Exchange @ L/O
22	Ack	Relief late - Continue
23	Ack	No relief available - Continue
24	Yes/No	Can you work late?
25	Ack	Evacuate bus
26	Ack	Shut down bus
27	Ack	Let passenger ride free
28	Ack	State the fare

Msg ID	Default Response	Description
29	Ack	Advise when back in-service
30	Ack	Advise when ready to resume service
31	Ack	Request passengers who are using ADA seats to move if seat is needed for ADA passenger
32	Ack	Do not use your cell phone while in-service
33	Ack	Check destination sign
34	Ack	Check engine area and report condition
35	Ack	Check for lost item and report
36	Ack	Clear bus dashboard
37	Ack	Turn off 4-way flashers
38	Ack	Slow down, too early
39	None	Voice system down, use canned text messages

MESSAGES FROM VEHICLES TO DISPATCH:

Message Text or Description	Vehicle Type	MDT Message Text
Silent Alarm	Fixed Route	N/A
Priority Req To Talk	Fixed Route	PRTT REQUESTED
Request To Talk	Fixed Route	RTT REQUESTED
Selected Request To Talk (not used)	Fixed Route	SRTT REQUESTED
Cancel Request To Talk	Fixed Route	CRTT REQUESTED
Invalid Movement	Fixed Route	N/A
Invalid Logon	Fixed Route	N/A
Override Logon	Fixed Route	N/A
Vehicle Logon – Assignment Mismatch	Fixed Route	N/A
Silent Alarm	Fixed Route	N/A
Video Incident Data Tagged	Fixed Route	N/A

Message Text or Description	Vehicle Type	MDT Message Text
Emergency: Bus On Fire	Fixed Route	EM: BUS ON FIRE
Emergency: Operator in Another Bus Hurt	Fixed Route	EM: OP HRT OTHR
Emergency: Assistance for Motorist/Pedestrian	Fixed Route	EM: ASST MOT/PED
Emergency: Assault on Operator or Passenger	Fixed Route	EM: ASLT OP/PAX
Emergency: False SAS	Fixed Route	EM: FALSE SAS
Emergency: Passenger Disturbance	Fixed Route	EM: PAX DSTB
Emergency: Robbery	Fixed Route	EM: ROBBERY
Emergency: Sex Offense	Fixed Route	EM: SEX OFFENSE
Accident: TTS Involved	Fixed Route	AC: TTS INVLVED
Accident: TTS Not Involved	Fixed Route	AC: TTS NOT INVLV
Accident: Blocking TTS Service	Fixed Route	AC: BLOCK SRVC
Accident: Injuries	Fixed Route	AC: INJURY
Accident: No Injuries	Fixed Route	AC: NON-INJ
Accident: Object Thrown at Bus	Fixed Route	AC: OBJ THROWN
Accident: Operator is Witness	Fixed Route	AC: OP WITNESS
Accident: Mechanic Needed	Fixed Route	AC: NEED MECH
Accident: Mechanic Accident	Fixed Route	AC: MECH ACCDT
Ramp: Wheelchair Boarding	Fixed Route	RP: WHLCHR ON
Ramp: Wheelchair Off	Fixed Route	RP: WHLCHR OFF
Ramp: Cannot Board Mobility Aid	Fixed Route	RP: NO BRD MB AID
Ramp: Cannot Use All Securements	Fixed Route	RP: NO USE SECUR
Ramp: Securement Refused	Fixed Route	RP: SECUR REFSE
Ramp: Wheelchair Passed Up, Bus Full	Fixed Route	RP: PU/ BUS FULL

Message Text or Description	Vehicle Type	MDT Message Text
Ramp: Wheelchair Passed Up, 2 On Board	Fixed Route	RP: PU/ 2 ON BRD
Mechanical: Engine - Hot/Overheating	Fixed Route	ME: ENG-HOT
Mechanical: Brakes	Fixed Route	ME: BRAKES
Mechanical: A/C or Heat or Defroster	Fixed Route	ME: A/C-HEAT-DEF
Mechanical: Air Pressure	Fixed Route	ME: AIR PRESS
Mechanical: Coolant Leak/Light	Fixed Route	ME: COOL LK/LT
Mechanical: Front Door	Fixed Route	ME: DOOR-FRONT
Mechanical: Loose Hatch	Fixed Route	ME: DOOR-HATCH
Mechanical: Rear Door	Fixed Route	ME: DOOR-REAR
Mechanical: Engine – Bus Will Not Start	Fixed Route	ME: ENG-NO STRT
Mechanical: Engine – Slow Bus	Fixed Route	ME: ENG-SLOW BUS
Mechanical: External – Bike Rack	Fixed Route	ME: BIKE RACK
Mechanical: External – Mirrors Loose/Broken	Fixed Route	ME: MIRRORS
Mechanical: External – Wipers	Fixed Route	ME: WIPERS
Mechanical: Fuel – Leak	Fixed Route	ME: FUEL-LEAK
Mechanical: Miscellaneous – General Malfunction	Fixed Route	ME: GEN MALF
Mechanical: Lights – Headsign	Fixed Route	ME: LT- HEADSIGN
Mechanical: Lights – Head/Tail Light Not Working	Fixed Route	ME: LT-HEAD/TAIL
Mechanical: Lights – Interior Lights	Fixed Route	ME: LT-INT
Mechanical: Lights – Signal Not Working	Fixed Route	ME: LT-SIGNAL
Mechanical: Request Bus Exchange	Fixed Route	ME: RQ BUS EXCH

Message Text or Description	Vehicle Type	MDT Message Text
Mechanical: Seat – Operator	Fixed Route	ME: SEAT-OP
Mechanical: Steering – Free Play	Fixed Route	ME: STEER-FREE
Mechanical: Steering – Hard	Fixed Route	ME: STEER-HARD
Mechanical: Stop Request - Annunciator - Chime	Fixed Route	ME: STOP/ANN/CHM
Mechanical: Suspension – Air Leak	Fixed Route	ME: SUSP–AIR LK
Mechanical: Suspension – Bellows	Fixed Route	ME: SUSP-BELL
Mechanical: Suspension – Kneeling	Fixed Route	ME: SUSP-KNEEL
Mechanical: Tires – Flat/Defective	Fixed Route	ME: TIRE-FLAT
Mechanical: Tires – Lug Nut/Seal Leak	Fixed Route	ME: TIRE-LUG/SEAL
Mechanical: Transmission – Light On	Fixed Route	ME: TRN-LT ON
Mechanical: Transmission – Oil Leak/Light	Fixed Route	ME: TRN-OIL LK/LT
Mechanical: Transmission – Slipping	Fixed Route	ME: TRN-SLIP
Farebox: Not Reading Metrocard	Fixed Route	FB: NO RD METRO
Farebox: Bill Jam	Fixed Route	FB: BILL JAM
Farebox: By Pass	Fixed Route	FB: BY PASS
Farebox: Coin Jam	Fixed Route	FB: COIN JAM
Farebox: Low Stock	Fixed Route	FB: LOW STOCK
Farebox: No Power	Fixed Route	FB: NO POWER
Farebox: Not Counting	Fixed Route	FB: NOT COUNTING
Farebox: Not Reading UFS	Fixed Route	FB: NO READ UFS
Farebox: Overpaid Fare $5 or More	Fixed Route	FB: OVRPAID FARE
Farebox: Transfer Problem	Fixed Route	FB: TRNFR PROB

Message Text or Description	Vehicle Type	MDT Message Text
Farebox: Trim Unit Out	Fixed Route	FB: TRIM UNIT OUT
Service: Alternate Route Requested	Fixed Route	SV: ALT RTE REQ
Service: Back In Service	Fixed Route	SV: BACK IN SRVC
Service: Bus Blocked	Fixed Route	SV: BUS BLOCK
Service: Bus Vandalism	Fixed Route	SV: BUS VNDLISM
Service: Lost Item Found	Fixed Route	SV: LOST ITM FND
Service: Detour, Going Off Route	Fixed Route	SV: DETOUR
Service: Missed Turn, Going Off Route	Fixed Route	SV: MISSED TURN
Service: Pass Up / Standing Load	Fixed Route	SV: PU/ OVRLD
Service: Passing Leader	Fixed Route	SV: PASS LEADER
Service: Request Schedule Assistance	Fixed Route	SV: RQ SCH ASST
Service: Request Turnaround	Fixed Route	SV: RQ TRN ARND
Service: Road Hazard	Fixed Route	SV: RD HAZARD
Service: Railroad Crossing Delay	Fixed Route	SV: RR XING DLY
Service: Report Shelter Vandalism	Fixed Route	SV: STOP VNDLISM
Operator: No Relief	Fixed Route	OP: NO RLF
Operator: Personal Emergency, Need Relief	Fixed Route	OP: PER EM ND RLF
Operator: Relief Operator 2 Minutes Late	Fixed Route	OP: RLF LATE
Operator: Operator More Than 10 Minutes Late	Fixed Route	OP: >10 MIN LATE
Operator: Request Supervisor	Fixed Route	OP: REQ SUPV
Operator: Request Transfers	Fixed Route	OP: REQ TRNFR
Operator: Sick Need Relief	Fixed Route	OP: SICK ND RLIEF

Message Text or Description	Vehicle Type	MDT Message Text
Passenger: Passenger Refusing To Pay Fare	Fixed Route	PS: PAX NO PAY
Passenger: Bicycle Left On Rack	Fixed Route	PS: BIKE ON RACK
Passenger: Bodily Fluids	Fixed Route	PS: BODY FLUIDS
Passenger: Courtesy Ride	Fixed Route	PS: COURTSY RIDE
Passenger: Courtesy Ride Complete	Fixed Route	PS: CRTSY RID OVR
Passenger: Passenger Asleep – End of Line	Fixed Route	PS: PAX SLP EOL
Passenger: Passenger Under the Influence	Fixed Route	PS: PAX UND INFL
Passenger: Passenger Fall, Injury	Fixed Route	PS: PAX FALL INJY
Passenger: Passenger Fall, Non-Injury	Fixed Route	PS: PAX NO INJY
Passenger: Passenger Lost / Disoriented	Fixed Route	PS: PAX LOST
Passenger: Passenger Requests Direction	Fixed Route	PS: PAX REQ DIR
Passenger: Passenger Sick – Request Cleanup	Fixed Route	PS: PAX SICK
Passenger: Problem Passenger Exited Bus	Fixed Route	PS: PROB PAX GONE
Passenger: Problem Passenger – Send Supervisor	Fixed Route	PS: PRB PAX SD SUP
Pre Trip Inspection: Inspection Complete, No Defects	Fixed Route	PT: NO DEFECTS
Pre Trip Inspection: Inspection Complete, Defects Found	Fixed Route	PT: DEFECTS
Pre Trip Inspection: Bike Rack	Fixed Route	PT: BIKE RACK
Pre Trip Inspection: Body Damage	Fixed Route	PT: BODY DAMAGE

Message Text or Description	Vehicle Type	MDT Message Text
Pre Trip Inspection: Camera Non Operational	Fixed Route	PT: CAM NON OP
Pre Trip Inspection: Cracked Windshield	Fixed Route	PT: CRK WNDSHD
Pre Trip Inspection: Dirty Bus – Interior	Fixed Route	PT: DIRTY BUS
Pre Trip Inspection: Doors	Fixed Route	PT: DOORS
Pre Trip Inspection: Emergency Exits	Fixed Route	PT: EMERG EXITS
Pre Trip Inspection: Fire Extinguisher - Triangles	Fixed Route	PT: FIRE EXT/TRI
Pre Trip Inspection: Head Lights – Interior Lights – Dash Lights	Fixed Route	PT: HD/INT/DSH LTS
Pre Trip Inspection: Headsign	Fixed Route	PT: HEADSIGN
Pre Trip Inspection: Heat – Air Conditioner – Blower Fan	Fixed Route	PT: HT/AC/BLWER
Pre Trip Inspection: Loose Mirror	Fixed Route	PT: LOOSE MIRROR
Pre Trip Inspection: Low Air Pressure	Fixed Route	PT: LOW AIR PRESS
Pre Trip Inspection: Marker Lights Broken	Fixed Route	PT: MARKER LTS
Pre Trip Inspection: Bus Will Not Start	Fixed Route	PT: NO START
Pre Trip Inspection: Operator's Seat – Seatbelt	Fixed Route	PT: OP SEAT/BELT
Pre Trip Inspection: Passenger Seat	Fixed Route	PT: PAX SEAT
Pre Trip Inspection: Steering Wheel – Horn	Fixed Route	PT: STR WHL/HRN
Pre Trip Inspection: Stop Request – Annunciator - Chime	Fixed Route	PT: STOP/ANN/CHM
Pre Trip Inspection: Tire Damage	Fixed Route	PT: TIRE DAMAGE

Message Text or Description	Vehicle Type	MDT Message Text
Pre Trip Inspection: Lug Nut	Fixed Route	PT: LUG NUT DAMATE
Pre Trip Inspection: Turn, 4-Way, Brake Lights	Fixed Route	PT: TRN/4WY/BK LT
Pre Trip Inspection: Wheelchair Ramp - Securements	Fixed Route	PT: WC RAMP/SEC
10-1 (Received Poorly)	Fixed Route	10-1
10-2 (Received Clearly)	Fixed Route	10-2
10-4 (Message Received or Affirmative)	Fixed Route	10-4
10-7 (Out of Service)	Fixed Route	10-7
10-8 (In Service)	Fixed Route	10-8
10-9 (Repeat Your Message)	Fixed Route	10-9
10-19 (Return to Location)	Fixed Route	10-19
10-20 (What is your Location? / My Location is...)	Fixed Route	10-20
10-21 (Call Dispatch by Phone)	Fixed Route	10-21
10-22 (Cancel Last Message or Assignment)	Fixed Route	10-22
10-23 (Stand By)	Fixed Route	10-23
10-31 (Radio Check)	Fixed Route	10-31
10-36 (Correct Time)	Fixed Route	10-36
10-44 (Backing Up Vehicle)	Fixed Route	10-44
10-50 (Cancel 10-44)	Fixed Route	10-50
10-99 (Wheelchair Boarding)	Fixed Route	10-99
10-100 (Restroom Break)	Fixed Route	10-100
CODE 1 Detour / Safety Notification	Fixed Route	CODE 1
CODE 2 Security / Police Needed at	Fixed Route	CODE 2
CODE 3 Paramedics / Ambulance Needed at	Fixed Route	CODE 3
CODE 4 No Further Assistance Needed	Fixed Route	CODE 4
CODE 5 Supervisor Needed at	Fixed Route	CODE 5

Message Text or Description	Vehicle Type	MDT Message Text
CODE 6 Fire Department Needed at	Fixed Route	CODE 6
Supervisor: En Route to TBD 1	Supervisor	SU: EN RT TBD 1
Supervisor: En Route to TBD2	Supervisor	SU: EN RT TBD2
Supervisor: En Route to TBD3	Supervisor	SU: EN RTE TBD3
Supervisor: Medic On Scene	Supervisor	SU: MEDIC ON SCN
Supervisor: Observation	Supervisor	SU: OBSERVE
Supervisor: On Scene	Supervisor	SU: ON SCENE
Supervisor: Reasonable Suspicion of Operator Under Influence	Supervisor	SU: OP UND INFL
Supervisor: Request Fire Department	Supervisor	SU: REQ FIRE DEPT
Supervisor: Request Medic	Supervisor	SU: REQ MEDIC
Supervisor: Request Police	Supervisor	SU: REQ POLICE
10-1 (Received Poorly)	Supervisor	10-1
10-2 (Received Clearly)	Supervisor	10-2
10-4 (Message Received or Affirmative)	Supervisor	10-4
10-7 (Out of Service)	Supervisor	10-7
10-8 (In Service)	Supervisor	10-8
10-9 (Repeat Your Message)	Supervisor	10-9
10-19 (Return to Location)	Supervisor	10-19
10-20 (What is your Location? / My Location is...)	Supervisor	10-20
10-21 (Call Dispatch by Phone)	Supervisor	10-21
10-22 (Cancel Last Message or Assignment)	Supervisor	10-22
10-23 (Stand By)	Supervisor	10-23
10-31 (Radio Check)	Supervisor	10-31
10-36 (Correct Time)	Supervisor	10-36

Message Text or Description	Vehicle Type	MDT Message Text
10-99 (Wheelchair Boarding)	Supervisor	10-99
10-100 (Restroom Break)	Supervisor	10-100

APPENDIX D. TYPES OF VEHICLES FOR TOM INSTALLATION

QTY	YEAR	MAKE	MODEL	HEAD SIGN	FLOOR	LENGTH	FUEL	ENGINE	TRANS	ELECT
5	1992	Gillig	Phantom	Luminator Max3000	High	40	Diesel	DDC S50 DDECIV	B400R AIEC ALLISON w/ Retarder	12/24 Volt
3	1996	Gillig	Phantom	Luminator Max3000	High	40	Diesel	DDC S50 DDECIV	B400R AIEC ALLISON w/ Retarder	12/24 Volt
6	1997	Gillig	Phantom	Luminator Max3000	High	40	Diesel	DDC S50 DDECIV	B400R AIEC ALLISON w/ Retarder	12/24 Volt
8	2000	Gillig	LowFloor	Luminator MegaMax3000	Low	40	Diesel	Cummins ISC 280 Electronic Control	B400R AIEC ALLISON w/ Retarder	I/O Controls Multiplex
11	2002	Gillig	LowFloor	Luminator MegaMax3000	Low	40	Diesel	Cummins ISC 280 Electronic Control	B400R AIEC ALLISON w/ Retarder	I/O Controls Multiplex
10	2010	NewFlyer	GE40LFR	Twin Vision Smart Series	Low	40	Gasoline	Ford Triton V10	ISE Thunder Volt Propulsion package	engine 12 / Hybrid capacitors 1400 volts
20	2011	NewFlyer	C40LFR	Twin Vision Smart Series	Low	40	Compressed Natural Gas	Cummins 8.9 ISL-G	Allison B400R	12/24 Volt

Road Supervisor Systems: Four 2009 Ford Escape Hybrids
Additional Supervisor Systems without MDCs: Two 2009 Ford Escape Hybrids, One service truck, Two TBD

APPENDIX E. PARTIAL LIST OF AVA PUBLIC SERVICE MESSAGES

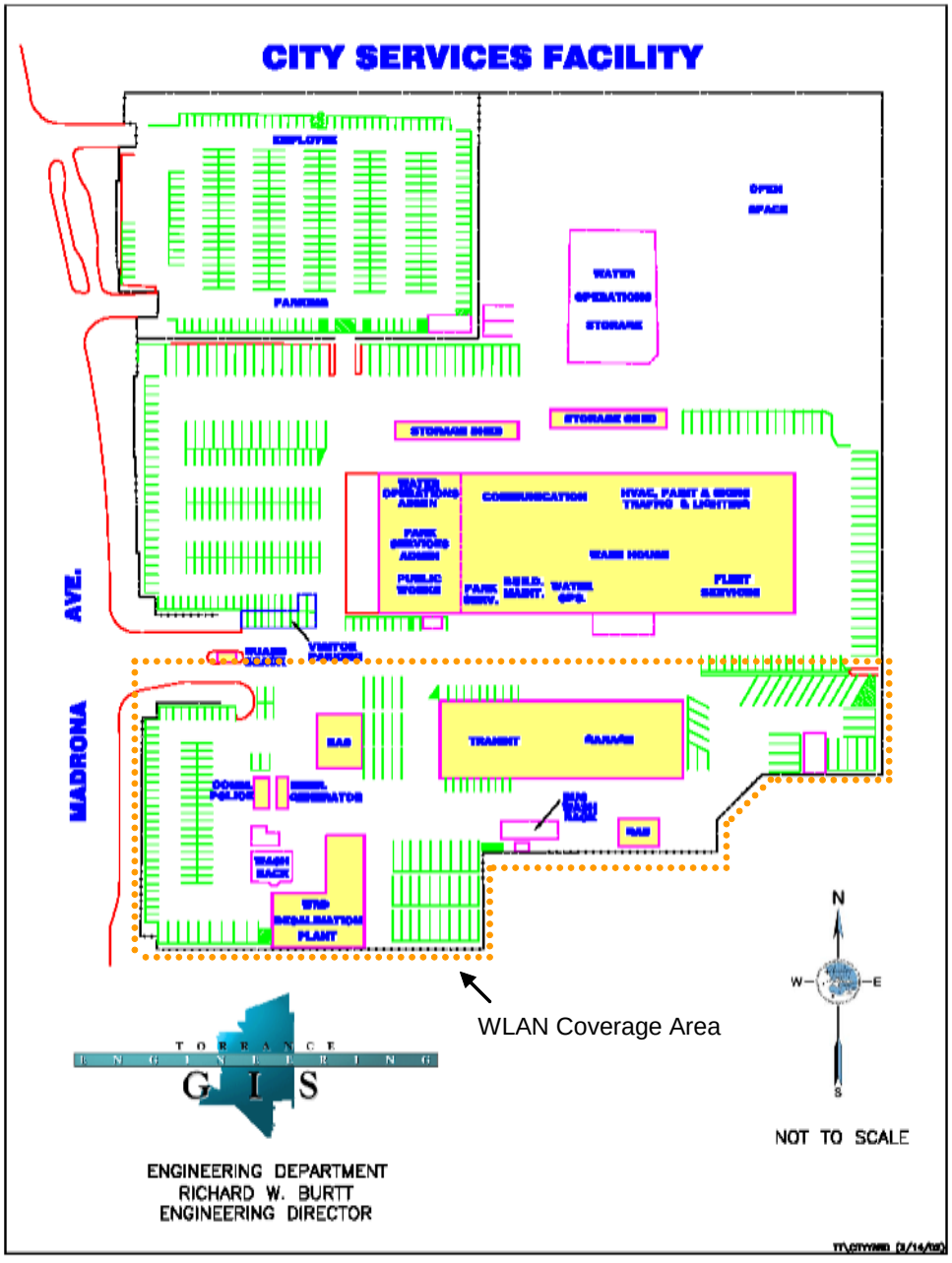
Drinking or eating on the bus is not allowed.
Visit TORRANCE TRANSIT on the web at www.torrnet.com
This bus is equipped with air conditioning. Please keep windows closed.
End of the line - the operator will be taking a short break.
Please offer your seat to a senior or disabled passenger.
Please report any graffiti or unusual activity to the operator.
Be sure you have retrieved all your personal belongings.
Please keep aisle clear of personal articles.
Thank you for riding Torrance Transit.
Smoking is not permitted on the bus.
Watch your step when exiting the bus.
Floors are slippery when wet.
Please exit through rear doors.
No unnecessary conversation with the operator.
Please hold on to hand rails when standing.
Please inform the operator before removing your bike from the bike rack.
As a courtesy to others, please do not put your feet on the seats.

Torrance Transit will operate on a Saturday schedule on Christmas Eve.
Torrance Transit will operate on a Saturday schedule on New Year's Eve.

Torrance Transit will operate on a Sunday schedule on Memorial Day.
Torrance Transit will operate on a Sunday schedule on Independence Day.
Torrance Transit will operate on a Sunday schedule on Labor Day.

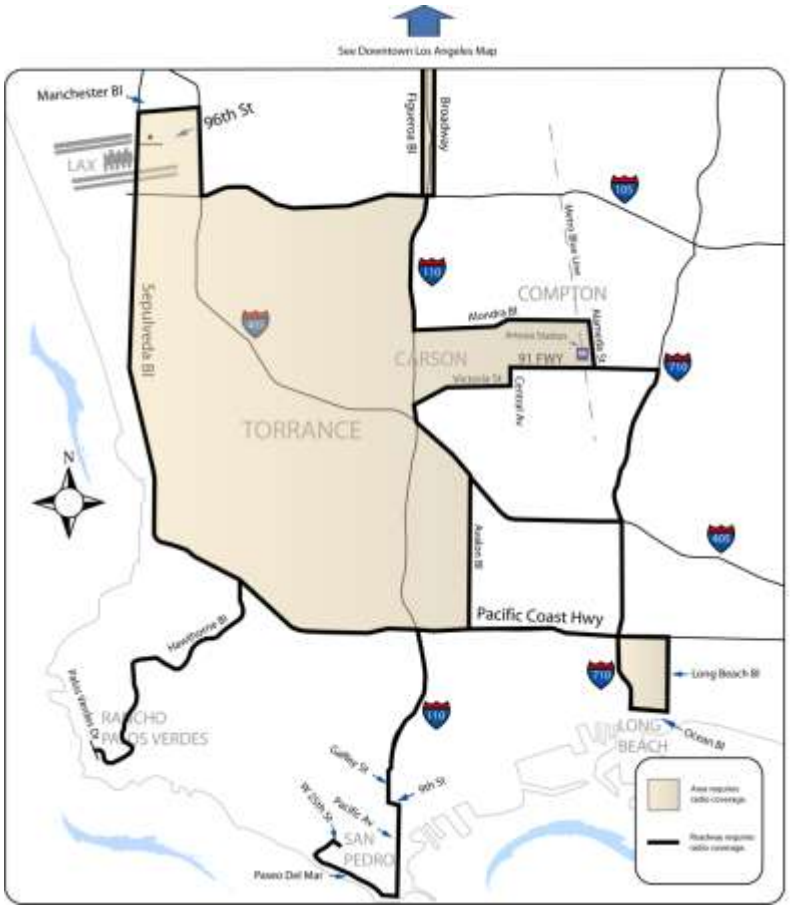
Torrance Transit will be closed on Thanksgiving Day.
Torrance Transit will be closed on Christmas Day.
Torrance Transit will be closed on New Year's Day.

APPENDIX F. TORRANCE TRANSIT SYSTEMS SITE DRAWING



APPENDIX G TORRANCE TRANSIT SYSTEMS BUS ROUTE MAP

APPENDIX H. TTS RADIO COVERAGE AREA



APPENDIX I. TORRANCE TRANSIT SYSTEMS RADIO LICENSES

Federal Communications Commission
Public Safety and Homeland Security Bureau

RADIO STATION AUTHORIZATION

Licensee: TORRANCE, CITY OF

FCC Registration Number (FRN): 0001527225

Call Sign	File Number
WXD691	0003114552

Radio Service: GP - Public Safety/Spec Emerg, 806-821/851-866 MHz, Conv.

Regulatory Status: PMRS

Frequency Coordination Number: 46GPAP870207333

JERRY A. EDWARDS
TORRANCE, CITY OF
20500 MADRONA AVENUE
TORRANCE CA 90503

Grant Date	Effective Date	Expiration Date	Print Date
11-27-2002	07-23-2007	02-05-2013	07-24-2007

STATION TECHNICAL SPECIFICATIONS

Fixed Location Address or Mobile Area of Operation

Loc. 1 Land Mobile Control Station meeting the 6.1 Meter Rule: CA

Loc. 2 Address
2016 CALLE DE ARBOLES
City: TORRANCE County: LOS ANGELES State: CA
Lat (NAD83): 33-48-14.0 N Long (NAD83): 118-22-6.0 W ASR No.: 1018556 Ground Elev: 125.0

Loc. 3 Area of Operation
Operating within a 97.0 km radius around fixed location number 2.

Antennas

Loc. No.	Ant. No.	Frequencies (MHZ)	Sta. Cls.	No. Units	No. Pagers	Emission Designator	Output Power (watts)	ERP (watts)	Ant. Ht./Tp meters	Ant. AAT meters	Construct Deadline Date
1	1	808.512500	FX1	2	0	20K0F9W	100.000	10.000			
1	1	810.962500	FX1	2	0	20K0F9W	100.000	10.000			
2	1	853.512500	FB2	1	0	20K0F9W	125.000	177.000	11.0	42.0	
2	1	853.512500	FB	1	0	20K0F9W	125.000	177.000	11.0	42.0	10-07-2005
2	2	855.962500	FB	1	0	20K0F9W	125.000	177.000	11.0	42.0	07-23-2008
2	2	855.962500	FB2	1	0	20K0F9W	125.000	177.000	11.0	42.0	07-23-2008
3	1	808.512500	MO	71	0	20K0F9W	100.000	35.000			
3	1	853.512500	MO	71	0	20K0F9W	100.000	35.000			
3	1	810.962500	MO	71	0	20K0F9W	100.000	35.000			07-23-2008
3	1	855.962500	MO	71	0	20K0F9W	100.000	35.000			07-23-2008

Conditions:
Pursuant to Section 309(h) of the Communications Act of 1934, as amended, 47 U.S.C. Section 309(h), this license is subject to the following conditions: This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term thereof nor in any other manner than authorized herein. Neither the license nor the right granted thereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934, as amended. See 47 U.S.C. Section 310(d). This license is subject in terms to the right of use or control conferred by Section 706 of the Communications Act of 1934, as amended. See 47 U.S.C. Section 606.

APPENDIX J. LIST OF CDRLS

Section	CDRL Description	Due Date
3.1.2.5	Data Protocols	PDR
3.1.3.5	FCC License Modification, if applicable	PDR
3.1.4.1	System reliability, availability, and maintainability report	PDR
3.1.5	Response time analysis report	PDR
3.1.6.3	Dispatch equipment installation requirements	PDR
3.1.6.4	Bus installation plans	PDR
3.1.6.5	Develop interfaces to all existing on board equipment	PDR
3.1.6.6	Develop interfaces to Utilities	PDR
3.1.6.7	Color mock ups of GUI	PDR
3.8.2.3	APC expected passenger count to correct stop correlation calculations	PDR
3.8.2.6	APC expected accuracy calculations	PDR
3.8.3.2	Announcement text approval	FDR
3.8.5.5	VHM subsystem design proposal	PDR
4.1	Scaled dispatch console drawings	PDR
4.2.3	UPS power and environmental load report	PDR
4.2.5.1	Building equipment installation and cabling plans	PDR
4.3.3	Power requirements	PDR
4.4.2	Mobile data communications protocol	PDR
4.4.3	Data radio power requirements	FDR
4.5.2	Antenna type submittal, if applicable	PDR
4.6.2	MDT mounting and system interface specifications	PDR
4.6.2.2.1	MDT physical specifications	PDR
4.6.2.2.2	MDT mounting structure physical specifications	PDR
4.6.13.2	Mounting details for LED Signs	PDR
4.6.15.5	VHM subsystem design proposal	PDR
4.6.16.1.2	On bus equipment power consumption specification	PDR
4.6.17	Bus equipment installation workplans	PDR
4.6.17	Bus installation log	BAT
4.6.17	Installation functional test plan	FDR
4.7.4	Yard subsystem installation drawings	PDR
4.7.4.1	Wireless LAN radio coverage calculations	PDR
4.8.4	Supervisor subsystem power consumption calculations	PDR
4.9.3.1.4	MDC mounting arrangement plans	PDR
4.9.4	Road supervisor subsystem power consumption calculations	
4.10.1	Electronic display installation details	PDR
4.10.1.4	Electronic display installation drawings	PDR
5.2.3	Progress meeting minutes creation	A
5.2.4	Progress meeting agenda creation	A
5.3.1	Detailed contract schedule	PDR
5.3.2.1	Monthly schedule update reports	A
5.3.3.3	Weekly four-week rolling schedule update reports	A
5.4.5	Test procedure description	FDR
5.4.6.1	Test results reports	PAT
5.5.1.3	Pre-final version of as built drawings	BAT
5.5.1.3	Final version of as built drawings	PAT
5.5.2	Computer software and data documentation	BAT
5.6.1.1	Conditions for initial closeout survey request	CL
5.6.2.1	Notice of completion for items noted during initial closeout survey	CL
5.7.15	Monthly status report	A
5.9	Quality assurance plan	PDR
5.9.1.1	Document management system	PDR
6.1	Manuals list	PDR
6.2.1	Proposed manual outline for preliminary design review	PDR
6.2.1	Proposed manual draft version for final design review	FDR
6.2.1	Complete set of accepted version of manuals	4WKSSC
6.2.1	Final version of manuals	2WKSSC

7.2	Complete training plan	FDR
7.3	Complete description of training courses	FDR
7.4	Training material for each trainee	SSC
7.4	Independent-study courseware	FDR
8	Spare parts list recommendations	FDR
9.4	Detailed test procedures	BAT
9.4	Detailed test results	BAT
9.6	Acceptance testing network failure report	AT
9.11	Acceptance testing system repair/correction report	AT
9.11.2	Acceptance testing human factors results report	AT
9.11.4	Acceptance testing database anomolies and corrections report	AT
9.11.5	System performance vs. availability and reliability report	AT
10	Submittals and design reviews	A
10.2	Preliminary design submittal	PDR
10.2.2	Software requirements specification document	PDR
10.3	Subsystem final design submittal	FDR
10.4	Design review workshops minutes	A
10.4	Design review workshops concerns	A

PDR = Preliminary Design Review
FDR = Final Design Review
BAT = Before Acceptance Test
PAT = Post Acceptance Test
A = As Needed
AT = Acceptance Test
CL = Closeout
4WKSSC = 4 Weeks Before SSC
2WKSSC = 2 Weeks Before SSC
SSC = Start of Scheduled Courses

APPENDIX K. CITY OF TORRANCE EQUIPMENT QUALITY INSTALLATION STANDARDS

Communications & Information Technology

Equipment Quality Installation Standards

ELECTRICAL -- DRAFT STANDARD

Date – January 7, 2008

GENERAL

Electrical equipment shall comply with all Federal Motor Vehicle Safety Standards and State of California Department of Motor Vehicle regulations. All electrical work and installation of equipment/devices shall be completed in a workmanlike manner, mechanically and electrically secure. All electrical components (communications and network equipment) requiring periodic service shall be reasonably accessible with provision of suitable wire length for service and repair work.

GENERAL EQUIPMENT REMOVAL REQUIREMENTS

All Communications & Information Technology equipment shall be removed non-destructively.

All equipment not reused for the current installation shall be returned to the City of Torrance Communications & Information Technology.

All aftermarket wiring modifications shall be returned to original OEM operation.

All aftermarket wiring shall be removed.

WIRING PRACTICES, WIRE & CABLE

All supplier installed wiring shall be the stranded copper type and shall have proper insulation. All splices shall be sealed against moisture. The ends of all stranded conductors shall be mechanically stripped and fitted with insulated type terminals. The terminals shall be mechanically crimped securely with appropriate tool(s). Appropriate tools shall be the following, or comparable, for use and purpose as applicable:

Wire Stripper: Ideal Industries, Inc., Catalog Number 45-215 [10-18 AWG], 45-247 [12-14 AWG]

Cable Stripper: Ideal Industries, Inc., Catalog Number 45-128.

Multi-Crimp Tool: Ideal Industries, Inc., Catalog Number 30-429.

Cutting Pliers: Klein Tools, Inc., Number 7YLL (1104).

Scotch Lock wire-piercing devices shall not be used.

Circuit Grounding

Ground terminal lugs shall be solder dipped, cadmium, tin, or zinc plated. Ground terminals shall be accessible for service. A serrated paint cutting terminal may be utilized to make proper contact on painted surfaces. Ground terminal devices shall be cadmium, tin, or zinc plated. In special cases, plating may not be required for lugs and/or attaching devices.

Conductor Splicing

Splices shall be insulated and mechanically secure to withstand all fabrication, installation and vehicle environment abuse.

Terminal and Connector Function

All connections shall be designed to maintain surety of connections while subjected to vibration, shock, and the extreme temperatures that are normal environmental conditions for motor vehicles. Surety may be accomplished by employing the use of integral-molded lock devices, terminal to terminal interferences (detents), secondary locking clips, or attaching devices.

All multiple connect-disconnect connector bodies shall be polarized to prevent incorrect assembly unless circuitry permits use of a non-polarized connector.

Connections shall be located in clean, dry areas when possible. Connections shall be designed to maintain circuit integrity regardless of environmental conditions (such as high humidity, road splash, rain, drainage, earth particles, fuels, lubricants, high and low temperatures and solvent).

Wire Assembly Construction

Wiring harness covering shall be adequate to protect the harness in the vehicle routing environment and shall furnish protection during all phases of vehicle assembly and operation.

Wire Assembly Installation and Protection

Wire routing shall be such that maximum protection is provided by the vehicle sheet metal and structural components. All supplier installed wiring shall be protected in vinyl plastic auto loom, or where applicable, rigid or flexible conduit. Suitable tubing or conduit for retaining cables and harnesses shall be securely attached to body or frame member and cable or harness. Clips also assist in locating and routing at assembly. The edge of all metal members which wire harness or loom pass through shall be de-burred, flanged, rolled, or bushed. In addition, all metal penetrations shall be fitted with suitable grommets.

Wiring shall be located to afford protection from road splash, stones, abrasion, grease, oil, and fuel. Wiring exposed to such conditions shall be further protected by either, or a combination of, the use of heavy wall thermoplastic insulated cable, additional tape application, plastic sleeve or conduit, nonmetallic loom, or metallic or other suitable shielding or covering.

Where cables must flex between moving parts, the last supporting clip shall be securely mounted and secure the cable in a permanent manner.

Wiring fasteners shall be nonconductive unless the wiring or fastener involved is provided with extra heavy outer covering such as nonmetallic conduit, tape, or dip. Overlay or option wiring should be routed in the same fasteners with standard wiring where practical, or should be fastened to the standard wiring with plastic straps or other mechanical means.

Electrical apparatus with integral wiring shall be supplied with grommets or other suitable mechanical fasteners for strain relief.

Wire Size

Refer to drawing provided by Communications & Information Technology Department Appendix A.

Through-hole protection

1. Whenever wires are run through holes in partitions, shields, and the like, less than 1/8" thickness, the holes shall be equipped with grommet. Panels 1/8" or more in thickness shall have grommets or shall have the hole edges rounded to a minimum radius 1/32" and abrasion protective covering on wires (e.g., loom).
2. Where wires and cables penetrate an enclosure, or are exposed to the outside environment, insulating weatherproof or watertight bulkhead fitting shall be used.
3. Wire or other penetrations of a cab shall only be inserted into the cab from below and shall meet the requirements of or. Cable access or mounting holes through the top or sides of a cab are not acceptable, except with prior approval from Communications & Information Technology department with the City of Torrance.

Cable and Wire Support

Adhesive backed tie holders are not acceptable in any application.

1. **Cab Exterior:**

   Wire and cable shall be properly supported at least every 18" and secured with insulated metal loop clamps to prevent undue stress on the conductors and terminals and undue change in position of the wire or cable during and after subjection of the equipment to specified service conditions.

2. **Cab Interior:**

   Only insulated metal loop clamps or screw mounted wrapping and tying devices are acceptable.

Cable Ties

Nylon cable ties may be used only for bundling of multiple conductor cables and wiring. When used, nylon cable ties shall be trimmed flush. Cable ties shall not be used as a means of support, except for interior, under dash locations where loop clamps cannot be installed. If used outdoors, then black UV stabilized nylon cable ties shall be used. It is permissible to use cable ties to tie wires to existing wire runs on rigid frame members. Cable ties shall be of adequate size to support the harness load.

Wire Routing

All wire routing shall conform to the following:

1. Shall be shielded from or routed away from heat sources.
2. Shall be protected or routed away from environmental exposure.
3. Shall not be placed under tension.

4. Shall be free and clear of any moving parts.
5. Wiring harness covering shall protect the harness in the operating environment and provide protection from road damage.
6. All mate able connectors shall be accessible during maintenance.
7. Cable and harnesses shall be routed along rigid sections of the cab or chassis where possible.
8. Wires shall be protected or secured away from sharp edges, including screw threads and from any other feature that might cut the insulation.
9. Wiring to components in exposed locations shall have a drip loop to prevent moisture from running up the wire.
10. The harness and cable ties, straps, etc., shall be neat in appearance, uniformly applied, and positioned to retain critical form factors and breakout locations. The containment means (lacing, ties, tie-down straps, etc.) shall not cause the wire or cable insulation to deform so that performance characteristics are adversely affected.

Slack

Wires and cables shall be as short as practicable, except that sufficient slack shall be provided to:

1. Prevent undue stress on cable , wires and connections, including connections to resiliently supported parts;
2. Enable parts to be removed and replaced during servicing without disconnecting other parts;
3. Facilitate field repair of broken or cut wires;
4. Units which are difficult to connect when mounted, shall be capable of movement to a more convenient position for connecting and disconnecting cables.

Appendix A

12 Volts Wire Sizes (Gauge) 3 % Drop for Radios

Total Wire Length in Feet

		10	**15**	**20**	**25**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Amp	**5**	18	16	14	12	12	10	10	10	8	8	8	6
	10	14	12	10	10	10	8	6	6	6	6	4	4
	15	12	10	10	8	8	6	6	6	4	4	2	2
	20	10	10	8	6	6	6	4	4	2	2	2	2

	25	10	8	6	6	6	4	4	2	2	2	1	1
	30	10	8	6	6	4	4	2	2	1	1	0	0
	40	8	6	6	4	4	2	2	1	0	0	2/0	2/0
	50	6	6	4	4	2	2	1	0	2/0	2/0	3/0	3/0
	60	6	4	4	2	2	1	0	2/0	3/0	3/0	4/0	4/0
	70	6	4	2	2	1	0	2/0	3/0	3/0	4/0	4/0	
	80	6	4	2	2	1	0	3/0	3/0	4/0	4/0		
	90	4	2	2	1	0	2/0	3/0	4/0	4/0			
	100	4	2	2	1	0	2/0	3/0	4/0				

24 Volts Wire Sizes (Gauge) 3 % Drop for Radios

Total Wire Length in Feet

		10	**15**	**20**	**25**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Amp	**5**	18	18	18	16	16	14	12	12	12	10	10	10
	10	18	16	14	12	12	10	10	10	8	8	8	6
	15	16	14	12	12	10	10	8	8	6	6	6	6
	20	14	12	10	10	10	8	6	6	6	6	4	4
	25	12	12	10	10	8	6	6	6	4	4	4	4
	30	12	10	10	8	8	6	6	4	4	4	2	2

	40	10	10	8	6	6	6	4	4	2	2	2	2
	50	10	8	6	6	6	4	4	2	2	2	1	1
	60	10	8	6	6	4	4	2	2	1	1	0	0
	70	8	6	6	4	4	2	2	1	1	0	0	2/0
	80	8	6	6	4	4	2	2	1	0	0	2/0	2/0
	90	8	6	4	4	2	2	1	0	0	2/0	2/0	3/0
	100	6	6	4	4	2	2	1	0	2/0	2/0	3/0	3/0

12 Volts Wire Sizes (Gauge) 10 % Drop for Lights **Total Wire Length in Feet**													
		10	**15**	**20**	**25**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Amp	**5**	18	18	18	18	18	16	16	14	14	14	12	12
	10	18	18	16	16	14	14	12	12	10	10	10	10
	15	18	16	14	14	12	12	10	10	8	8	8	8
	20	16	14	14	12	12	10	10	8	8	8	6	6
	25	16	14	12	12	10	10	8	8	6	6	6	6
	30	14	12	12	10	10	8	8	6	6	6	6	4

	40	14	12	10	10	8	8	6	6	6	4	4	4
	50	12	10	10	8	8	6	6	4	4	4	2	2
	60	12	10	8	8	6	6	4	4	2	2	2	2
	70	10	8	8	6	6	6	4	2	2	2	2	1
	80	10	8	8	6	6	4	4	2	2	2	1	1
	90	10	8	6	6	6	4	2	2	2	1	1	0
	100	10	8	6	6	4	4	2	2	1	1	0	0
	150	8	8	4	4	2	2	1	0	0	2/0	2/0	2/0
	200	6	6	4	4	2	1	2/0	2/0	2/0	4/0	4/0	4/0

24 Volts Wire Sizes (Gauge) 10 % Drop for Lights **Total Wire Length in Feet**													
		10	**15**	**20**	**25**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Amp	**5**	18	18	18	18	18	18	18	18	16	16	16	16
	10	18	18	18	18	18	16	16	14	14	14	12	12
	15	18	18	18	16	16	14	14	12	12	12	10	10
	20	18	18	16	16	14	14	12	12	10	10	10	10
	25	18	16	16	14	14	12	12	10	10	10	8	8
	30	18	16	14	14	12	12	10	10	8	8	8	8

	40	16	14	14	12	12	10	10	8	8	8	6	6
	50	16	14	12	12	10	10	8	8	6	6	6	6
	60	14	12	12	10	10	8	8	6	6	6	6	4
	70	14	12	10	10	8	8	6	6	6	6	4	4
	80	14	12	10	10	8	8	6	6	6	4	4	4
	90	12	10	10	8	8	6	6	6	4	4	4	2
	100	12	10	10	8	8	6	6	4	4	4	2	2